

AD-A141 992

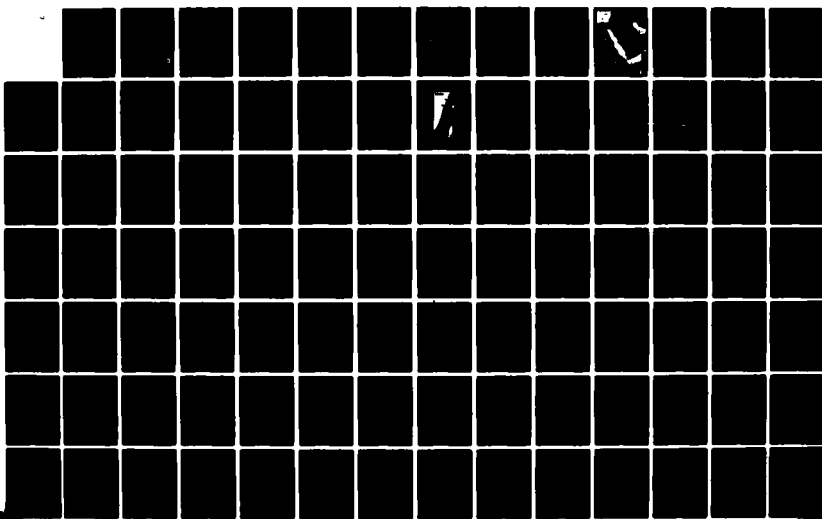
WATER AS A SOURCE OF COOPERATION OR CONFLICT IN THE
MIDDLE EAST(U) PENNSYLVANIA UNIV PHILADELPHIA MIDDLE
EAST RESEARCH INST T NAFF 14 MAY 84 MDA908-83-C-1542

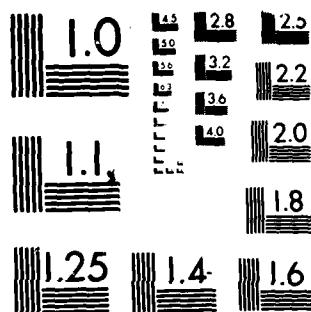
1/3

UNCLASSIFIED

F/G 8/8

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

D

MARKUP DRAFT

MARKUP DRAFT

MARKUP DRAFT

MARKUP DRAFT

AD-A141 992

WATER AS A SOURCE OF COOPERATION
OR CONFLICT IN THE MIDDLE EAST

Defense Intelligence Agency
MDA 908-83-C-1542 P001

DTIC FILE COPY

Principal Investigator:
Dr. Thomas Naff, Director
Middle East Research Institute
University of Pennsylvania
3808 Walnut Street
Philadelphia, PA 19104
(215) 898-6077

DTIC
ELECTE
JUN 12 1984
S
E
D

This document has been approved
for public release and notes its
distribution is unlimited.

84 05 17 056



DEPARTMENT OF DEFENSE
DEFENSE INTELLIGENCE COLLEGE
WASHINGTON, D.C. 20374

U-1757/DIC-P

14 MAY 1984

TO: Distribution List

SUBJECT: Defense Academic Research Support Program (DARSP)

1. In February 1982, the Director, Defense Intelligence Agency, inaugurated the subject program to acquire scholarly, unclassified research studies and other scholarly services focusing on socio-political and other factors affecting stability in the Third World. The DARSP is administered by the Defense Intelligence College (DIC). Devised to support analyses within the General Defense Intelligence Program (GDIP) community, the DARSP seeks also to establish and develop contacts between GDIP analysts, DIC and scholar-specialists/experts on the Third World, and to obtain supplemental instructional material for the DIC.

2. You received recently, for use and review, copies of the first in a series of DARSP-supported research studies on the Middle East. Enclosed for the same purposes is a copy (copies) of a study on "Water as a Source of Cooperation or Conflict in the Middle East." We solicit your careful review and appraisal of this study for its content, usefulness for analysts, and its potential as a vehicle for stimulating analyst-scholar exchanges and relations. If analysts wish, DIC will try to arrange contact with the study's authors.

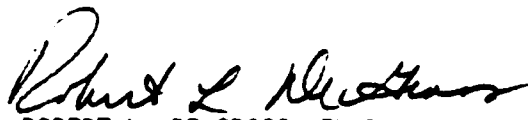
3. FY1984 has been designated as a review period for DARSP studies, and for an assessment of the worth and validity of the program proper. Your comments, therefore, will be most appreciated. We have received some appraisals on the first DARSP-supported Middle East study on "The Future of Islamic Fundamentalism in the Arab World in the 1980's," and find them very helpful. We will welcome assessments of that study from those who have not yet submitted them.

4. We request by 29 June 1984 your comments on the study on Water as a Source of Cooperation, and your views on the DARSP. Your responses need not be lengthy. Please address them to the undersigned.

1 Enclosure a/s

DISTRIBUTION LIST:

See pages 2-4


ROBERT L. DE GROSS, Ph.D.
Provost

DISTRIBUTION LIST

DoD and Joint Activities

Office of The Under Secretary of Defense for Policy
Department of Defense
Pentagon, Room 4E830
Washington, D.C. 20301

Office of The Assistant Secretary (International
Security Affairs)
Department of Defense
Pentagon, Room 4E808
Washington, D.C. 20301

Joint Chiefs of Staff
Director J-5 (Plans and Policy)
Department of Defense
Pentagon, Room 2E996
Washington, D.C. 20301

Defense Technical Information Center
Cameron Station Building 5
Alexandria, VA 22314

Navy

Commanding Officer
Naval Intelligence Support Center
4301 Suitland Road
Washington, D.C. 20390

Director Naval Intelligence
Department of the Navy
Pentagon, Room 5C600
Washington, D.C. 20350

Commander, Naval Intelligence Command
Naval Intelligence Command Headquarters
4600 Silver Hill Road
Washington, D.C. 20389

President
Naval War College
New Port, RI 02840

Superintendent
United States Naval Academy
Annapolis, MD 21402

Naval Operational Intelligence Center
4301 Suitland Road
Washington, D.C. 20390

Commanding Officer
Fleet Intelligence Center Europe & Atlantic
Norfolk, VA 23511

Commander Sixth Fleet
FPO, NY 09501

Commander in Chief
Military Airlift Command
Scott Air Force Base, IL 62225

Naval Advisor
Commander in Chief
Allied Forces Central Europe
Brunssum, The Netherlands

Commander
Intelligence Center, Pacific
Box 38
Camp H.M. Smith, HI 96681

U.S. Army

Commander
U.S. Army John F. Kennedy
Center for Military Assistance
Fort Bragg, NC 28307

Commander
USAITAC
Arlington Hall Station
Arlington, VA 22212

HQ DAMI
Washington, D.C. 20310

Commandant
U.S. Army Command and General Staff College
Fort Leavenworth, KS 66027

Commandant
U.S. Military Academy
West Point, NY 10996

U.S. Air Force

HQ USAF
ATTN: INE
Washington, D.C. 20330

AFSAC
Ft Belvior, VA 22060

USAF Academy
Colorado Springs, CO 80840

Air University
ATTN: LSE
Maxwell AFB, AL 36112

AFIS-DPT
Ft Belvior, VA 22060

Others

Central Intelligence Agency
ATTN: NFIC
Washington, D.C. 20505

Central Intelligence Agency
ATTN: NIO
Washington, D.C. 20505

National Security Agency
9800 Savage Road
Fort Meade, MD 20755

Library of Congress
Washington, D.C. 20540

Department of State
Office of Intelligence and
Research, Room 6510A
Washington, D.C. 20520

No thirst is so great as the fear of thirst
by the man whose water skins are full.

-- Khalil Gibran

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	<input checked="" type="checkbox"/>
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A1	



TABLE OF CONTENTS :

	PAGE
I. ABBREVIATED INTRODUCTION	1
II. THE JORDAN RIVER	8
Hydrology of the Jordan River	9
- North Fork of the Jordan	9
- Yarmuk River	12
- Lower Jordan River	12
- Ground water	13
History of the Jordan	15
- Conflict Crystallization: 1921-1948	15
- The Search for Cooperation: 1948-1955	20
- Unilateral Implementation: 1955-1967	30
- Militarization of the Water Conflict: 1967-1971	32
- Return to Unilateral Implementation: 1971-1983	34
Technical Aspects of the Jordan River System	42
- Water Quality	43
- Water Development Plans	43
- Water Consumption	47
Overview of Present Status	49
III. THE LITANI RIVER	52
Hydrology of the Litani River	53
History of the Litani	55
- Search for Cooperative Solutions: 1948-1955	55
- Problems of Implementation: 1955-1970	57
- Activation of the Litani Issue: 1970-1983	60
Technical Aspects of the Litani River	65
- Water Quality	65
- Water Development Plans	65
- Redistribution of Water	67
- Water Usage	69
Overview of the Present Situation	71

IV. THE EUPHRATES RIVER AND THE SHATT AL-ARAB	72
Hydrology of the Euphrates and Shatt al-Arab Rivers	73
- Introduction	73
- Euphrates River	73
- Tigris River	74
- Shatt al-Arab	74
- Kharun	75
- Discharge	76
History of the Euphrates River	78
- Pre-Critical Modern Development: 1904-1974	78
- The Syrian-Iraqi Water Crisis of 1974-1975	82
- Growing Water Resource Strain: 1975-2000	84
The Shatt al-Arab Dispute	88
- The Shatt al-Arab and Border Questions Prior to 1823	89
- British and Russian Intervention and the Treaty of 1847	90
- The 1913 Protocol	92
- World War I & II: The Shatt Question Before the League of Nations	93
- Post World War II: Regional Contenders in a Bi-Polar World	95
- Conclusion	99
Technical Aspects of the Euphrates & Shatt Al-Arab	101
- Water Quality	101
- Water Development Plans	103
- Redistribution of Water	105
- Water Usage	106
Overview of the Present Situation	107
V. THE ORONTES RIVER	108
Hydrology of the Orontes River	109
- Nature Regime and Discharge	112
History of the Orontes River	112
- Traditional Use	112
- Modern Development	112
Technical Aspects of the Orontes	116
- Water Quality	116
- Redistribution of Water	117



Precio

Ever
legan
hithis
good
determ
men a
Toda
naps a
manis
the cin
underl
hall's
tory of
the acor
to grow
where
vond th
the get
Para
-trough
enginee
taped a
supher
planes
have be
ing mo

Overview of the Present Situation	118
VI. THE NILE RIVER	121
The Hydrology of the Nile River	122
- Sources of the Nile	122
- Basic Characteristic of the System	125
History of the Nile	
- Initial Cooperation: 1920-1945	131
- Period of Crisis: 1945-1958	136
- Period of Cooperation: 1958-1983	139
Technical Aspects of the Nile	145
- Water Quality	145
- Water Consumption and Demand	147
- Water Management Schemes on the Nile	150
Prospects for Cooperation and Conflict	155
VII. INTERNATIONAL LEGAL ASPECTS OF MIDDLE EASTERN RIVERS	160
The Nature of International Law	160
- Sources of International Law	160
- Processes by which International Law is applied	164
Conflict of Cooperation over Consumptive Uses	167
- The Jordan in International Law	169
- Groundwater in Israel	177
- Imported Water	178
- Policy Proposals for the Jordan	180
- Other rivers used consumptively	183
Conflict Over Nonconsumptive Uses	185
- The Shatt Boundary Treaties	187
- A Legal Solution to the Shatt Problem	189
Questions for Further Study	192

VII. MIDDLE EAST WATER:	
THE POTENTIAL FOR CONFLICT OR COOPERATION	194
Conflict	197
Interests and Issues	198
Modeling Water Conflict:	
Interests, Riparian Position, Power	208
VIII. BIBLIOGRAPHY	213

ABBREVIATED INTRODUCTION

ABBREVIATED INTRODUCTION TO THE RIVER SYSTEMS
(for the mark-up draft)

The six river systems under examination flow through a region characterized by:

- a. semi-arid to hyperarid climate
- b. an abundance of unequally distributed natural resources, primarily hydrocarbon fuels
- c. an acute scarcity of water
- d. a very long history of management of water resources
- e. an equally long history of conflict, more often over water than over hydrocarbon fuels

These riverine waterways are (see Figure 1) the Nile, the Jordan, the Litani, the Orontes, the Euphrates, and the Shatt al-Arab. All are permanent watercourses in semi-desert to desert land, and as such they assume importance far out of proportion to their modest discharges. For example, the Nile is the longest river in the world, its drainage area is the fourth largest in the world, but its total discharge is less than at least 50 other rivers in the world (e.g., the Susquehanna).

Each of the six rivers acquires its runoff far from the major concentrations of users; in every case but the Litani, water is used outside present and historic boundaries of countries in which that discharge is generated by rainfall. Even in the case of the Litani, this situation is effectively, if not "legally," altered as a result of the Israeli invasion of Lebanon. Israel now controls a portion of the Litani upstream from Lebanese users; once more, fears of an Israeli diversion of the upper Litani into the headwaters of the Jordan, a strategy developed to

the point of near-implementation by Israel in the past, are being voiced.

Seasonal variation of the flow of all six rivers is extreme. All except the Nile are fed by winter rainfall over the highlands of the eastern Mediterranean that is generated along fronts of interference between air masses of contrasting thermal history. These air masses are driven across the Mediterranean from west to east by the belt of prevailing westerly winds that is depressed toward the Equator for a few months during and shortly after the December solstice. This precipitation is highly variable in its annual amount and in the timing of its arrival. Long-term water-management plans encounter frequent but unpredictable crises of supply to the extent that they are not predicated on worst-case precipitation scenarios (see Figure 2 for annual rainfall values). Dry season base flow of the rivers is maintained by ground-water inflow in those parts of the watersheds where local water tables lie topographically above the beds of the streams. This contribution varies over many orders of magnitude as a function of local bedrock conditions.

The Nile in typical years acquires 90 percent of its discharge from late summer monsoonal precipitation over the Ethiopian highlands, from which spring the major Nile tributaries -- the Atbara and the Blue Nile. The monsoonal weather pattern is generated by the migration of the Inter-tropical Convergence Zone (ITCZ), which reaches its most northerly position sometime after the June solstice. Both the volume and the timing of that precipitation are subject to considerable variation, a topic of interest in the time of the Pharaohs long before the configuration of the upper Nile was known to any of its downstream users. The unpredictability of that discharge and the sheer volume of the portion of that discharge that flows unused to the Mediterranean during a few months of

the year have inspired many grandiose schemes for aggressive management of the entire basin.

Because they flow through desert regions in the downstream segments of their courses, all of these rivers undergo systematic decrease in discharge as a result of efficient evaporation (1.8 to 2.5 m/yr) to a desiccated atmosphere and infiltration to a local water table that is typically depressed with reference to the elevation of stream flow.

The combination of evaporation and nonconsumptive uses reduces the water quality of each of these rivers to the extent that several carry concentrations of dissolved solids in their downstream reaches that exclude cultivation of salinity-sensitive crops. This condition also imposes severe constraints on the design of current and future irrigation systems.

In addition to having nurtured the development of some of the most comprehensive water-management schemes of antiquity, this region has witnessed the implementation of some of the most ambitious water-management initiatives of modern times. Many of these systems were planned during a colonial era when western European governments could aspire to comprehensive control of entire basins. The realities of mid-20th century politics, however, have dashed those hopes. Current water-management developments in the region represent, at best, piecemeal realization of components of larger schemes, and fall short of the benefits that might be realized by all water users from basin-wide management of available water resources.

At least one of the six rivers, the Jordan, has been developed to the point that no further usable water resources can be extracted from the system. Redistribution of the water is possible using various diversion strategies, but selective exploitation of the highest-quality water

available in the Jordan system has already increased the salinity of downstream water supplies to concentrations that render it unfit for many uses.

Problems of water use in the region are further exacerbated by a surviving tradition (reinforced by current ideologies) of agriculture in conditions under which modern agriculture may be pursued only through application of massive energy and water subsidies. This is not unique to the Middle East — the United States food industry now expends nine calories of fossil fuel for every calorie of food value delivered to an American household — but in Middle Eastern and in particular Israeli agriculture, the energy subsidy to the agricultural sector is absurdly high, in large part because of the great expense of bringing sufficient irrigation water to the most productive soils. Fully one-fifth of the energy resources currently consumed in Israel is used for pumping water, and 80 percent of that water is for agriculture. Israel's per capita annual water use — in excess of 500 m³ — is on a par with that of the major industrialized countries where water resources are exponentially greater. If this pattern of use continues, Israel will have depleted its domestic water supplies by the mid 1990s, which adds critical complicating factors to the issue of its occupation of the West Bank, the Golan Heights, and southern Lebanon.

The energy subsidy of agriculture in North America has declined from the order of 10:1 since the cost of energy began to escalate in the mid-1970s, and shows signs of declining still further, but the energy subsidy of Middle Eastern agriculture is largely fixed by the enormous cost of carrying on intensive agriculture in a climate totally unsuited to such exploitation. In an extreme scenario of total collapse of the energy-

distribution system, North America could eventually revert to subsistence agriculture by a dispersed population; in the Middle East the limited productivity of the lower Nile Valley, the Fertile Crescent, and the narrow Mediterranean coastal plain with its seasonal rainfall could never support the rapidly growing population of the region.

Middle Eastern governments may yet realize that their energy resources will serve them better if they are exchanged, by whatever market strategy seems most appropriate, for foodstuffs produced at far lower energy subsidies in localities favored with climates better suited to agriculture. This strategy would enable Middle Eastern water authorities to transfer enormous quantities of water from the consumptive use of inefficient agriculture to be used for non-consumptive industrial applications.

However, the bitter territorial and ideological disputes among all the countries drained by the six river systems have, at best, fragmented the comprehensive water development schemes essential to the most efficient management of the region's waters; at worst, these disputes have blocked cooperative efforts altogether. The failure to resolve these conflicts and the injection of great power rivalries into the Middle East have made these issues more complex, apparently more intractable, and far more urgent.

Notes on the Data Base

A scattering of data, published and disseminated before the June 1967 (Six-Day) war between Israel and her Arab neighbors, is available. Since that war most published data has been generated by the various

official Israeli agencies that deal with water supply and its development. Little information from the Arab countries post-dates the 1967 war.

In evaluating the Israeli data generated after 1967, it is difficult to separate statements of fact from statements of ideology. In particular, it seems that official statements from Israeli government sources have carefully skirted the convergence of circumstances that Stauffer refers to as the Hydraulic Imperative - Israel's need to acquire and develop new water resources as the water demand to sustain the Israeli objective of an agriculturally based economy grows in magnitude.

The data base for the Jordan River system is much more extensive than the base we have identified for the other river systems.

THE JORDAN RIVER



HYDROLOGY OF THE JORDAN RIVER

The Jordan River is a complex system, consisting of a number of segments whose hydrologic characteristics differ so markedly from one another that the basin can be divided conveniently into a number of sub-basins (see map of Figure 3).

North Fork of the Jordan

The discharge that feeds into the upper part of the Jordan River is derived principally from a group of karstic springs located on the western and southern slopes of Mount Hermon (Jebel esh-Sheikh).

The largest of these springs is the Dan Spring, which rises from Jurassic carbonate rocks and supplies a large and relatively steady flow that responds only slowly to rainfall events. The average discharge of the Dan spring is 239 MCM/yr. which makes up effectively the entire flow of the Dan River (called the Nahal Liddani in Israel). The Dan spring is the least variable in discharge among the major karstic sources of the upper Jordan; its discharge varies from 173 to 285 MCM/yr. The Dan typically represents 50 percent of the discharge of the upper Jordan.

The Hasbani River (the Nahal Senir in Israel) derives most of its discharge from two springs, the Wazzani and the Hazbieh, the latter - a group of springs on the uppermost Hasbani. All of the springs rise from subsurface conduits in cavernous cretaceous carbonate rocks. The combined discharge of these two springs averages 138 MCM/yr. but the range of values measured varies over a greater range than do the measurements at the Dan Spring. Over a recent 20-year period the flow of the Hasbani

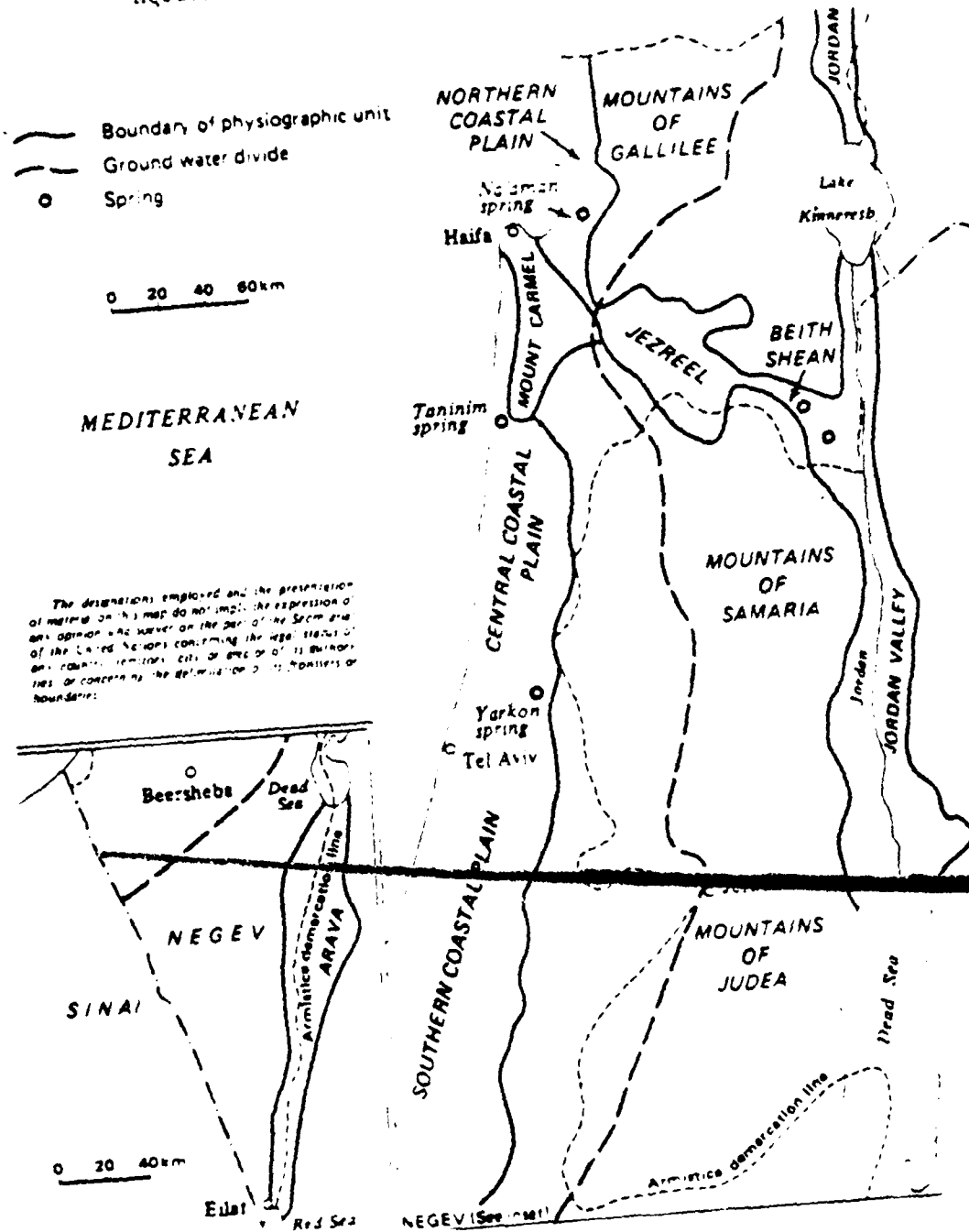
varied from 52 to 236 MCM/yr. Hasbani discharge responds much more rapidly to rainfall events than does the discharge of the Dan Spring.

The Baniyas River (Nahal Hermon in Israel) is fed primarily from the Hermon spring that issues from the contact of Quaternary sediments over Jurassic limestone in the extreme northeast portion of the Jordan Valley. The average discharge of the Hermon Spring is 117 MCM/yr; during a recent 20-period its discharge varied from 63-190 MCM/yr.

In a typical year, the karstic springs provide 50 percent of the discharge of the upper Jordan River; the rest is derived from surface runoff directly after the winter rainfall events. In dry years, spring outflow may make up as much as 70 percent of the flow of the upper Jordan. The Dan Spring, the largest of the sources of the upper Jordan, lies wholly within Israel close to the border with Syria. The spring sources of the Hasbani River lie entirely within modern Lebanon. The spring source of the Baniyas River is in Syria. These three small streams unite 6 km inside Israel at about 70 m above sea level to form the upper Jordan River.

All three spring systems provide more water than can be accounted for as a result of rainfall over their immediate watersheds; thus, it is surmised that the springs represent the outflow of a large, regional aquifer. Isotopic considerations indicate that there is considerable exchange of water from one spring to another. The combined outflow of the springs and the precipitation that falls on the surface watershed of the Upper Jordan is of the order of 500 MCM/yr. This discharge flows into the north end of Red Sea Rift Valley, where pre-Miocene bedrock has been displaced downward along border faults to form a deep, linear trough, the floor of which lies far below sea level. This trough has

AQUIFERS OF THE JORDAN RIVER



been partially filled since Miocene time with a complex column of wadi alluvium, volcanic rocks, and lake sediments deposited on the floor of a recurring inland lake that typically has been hypersaline; these processes continue today. The flow of the upper Jordan enters Lake Huleh, a small body of fresh water that receives additional volume from the flow of sublacustrine springs. Beyond Lake Huleh the North Fork of the Jordan falls 200 m to Lake Tiberias, the Sea of Galilee of the Bible, and Yam Kinneret of modern-day Israel, which lies at 210 m below sea level; the upper Jordan contributes an average of 660 MCM/yr to the lake, or about 40 percent of Israel's total identified usable water budget. An additional 130 MCM/yr enters Lake Tiberias as winter runoff from various wadis and in the form of discharge from sublacustrine springs, many of which are so salty that their contributions to the lake volume exacerbate its salinity problem. Israel has been damming the largest and saltiest of these springs in recent years.

The salinity of Lake Tiberias varies from a low value of 260 ppm to a high of 400 ppm; this variation depends primarily on the flow of the upper Jordan, in which salinity does not exceed 15 ppm.

~~about 200 MCM/yr is lost from the surface of Lake Tiberias by direct~~
evaporation. About 500 MCM/yr leaves Lake Tiberias via its outlet that flows south along the floor of the Dead Sea Rift for about 10 km to the confluence of the Yarmuk River. The volume of Lake Tiberias is of the order of 4,000 MCM/yr, 6.5 times the annual volume of the upper Jordan inflow and 8 times the annual Jordan outflow.

Figure 4 shows monthly and annual flows of the Jordan and its tributaries.

Yarmuk River

The Yarmuk River originates on the eastern margin of the Rift in a complex of wadis developed in Quaternary volcanic rock overlying late Mesozoic and early Cenozoic carbonate rocks. Of the 7252 sq km of the Yarmuk basin, 1,424 lie within Jordan and 5,828 within Syria. Flow of the Yarmuk is derived from winter precipitation that averages 364 mm/yr over the basin. Flow of the Yarmuk is supplemented by spring discharge where surface water is briefly abstracted underground in highly permeable zones in the lavas; some further spring discharge may be channeled to the surface on wadi floors via solution pathways in the underlying limestones. Salinity of the Yarmuk does not exceed 15 ppm. The main trunk of the Yarmuk forms the present boundary between Syria and Jordan for 40 km before it becomes the border between Jordan and Israel; where it enters the Jordan 10 km below Lake Tiberias, the Yarmuk contributes about 500 MCM/yr, none of which is contributed from the part of the valley where Israel is a riparian.

Lower Jordan River

South of the confluence of the Yarmuk, the Jordan flows on the surface of the late Tertiary rocks that partially fill the Rift Valley. For the first 40 km the river forms the boundary between Israel and Jordan; south of that reach, it enters pre-1967 Jordan (presently it forms the border between the West Bank, or Judea and Samaria of Israel, and modern Jordan). The Jordan here flows through the deepest subaerial portion of the Rift Valley to enter the Dead Sea at 398 m below sea level, the lowest point on the surface of the Earth. Between Lake Tiberias and the Dead Sea the Jordan is incised into a shallow valley, across which it

meanders for about 320 km in broad loops; the walls of the valley are cut primarily in the saline marls known as the Lisan Formation, that were deposited on the floor of the largest Pleistocene lake known to have occupied this part of the Rift, ancient Lake Lisan. Runoff from winter rainfall within the valley is carried to the Jordan via steep, intermittent tributary wadis incised in the walls of the Jordan Valley, primarily on the east. This source represents an additional 523 MCM/yr, of which only 20 percent originates in Israel; 286 MCM/yr is derived from perennial spring flow, while 237 MCM/yr is provided by winter rainfall.

Figure 4 is a plot of the Jordan River system, showing both average flows for the various segments and the ranges of salinities that are encountered in those portions.

The total area of the Jordan River basin is 18,300 sq km of which 3 percent lies in pre-1967 Israel. In the absence of irrigation extraction, the Jordan system delivers an average annual flow of 1,850 MCM to the Dead Sea; this is 2 percent of the annual flow of the Nile and 7 percent of the annual flow of the Euphrates; 23 percent of this discharge originates in post-1967 Israel. The annual flow of the Jordan is almost double the amount of water available from all other sources in Israel, and three times the amount of water available from all other sources in Jordan.

Ground Water

The principal discharge of the Jordan River is contributed by ground-water inflow, primarily to the extreme Upper Jordan and the headwaters of the Yarmuk. This is supplemented by spring flow to the lower parts of the system, but much of that contribution is so saline that its

effect is to degrade water quality. Winter rainfall along the west bank of the Jordan in post-1967 Israel recharges an important aquifer that is exploited along the Israeli coastal plain; present-day Israeli water-management schemes take pains to protect this recharge area and to maintain the rate of recharge.

THE HISTORY OF THE JORDAN RIVER

Conflict over the Jordan River System has been intractable because of two factors: (1) The System has a complex hydro-geological structure shared by four riparians; Table 1 lists the subdivision of the system. (2) The Jordan River involves four hostile riparian states: Israel, Jordan, Lebanon, and Syria; the Arab-Israeli conflict has overshadowed efforts to reach agreement on cooperative utilization of the water system.

Conflict Crystallization: 1921-1948

While Syria-Palestine was under the Ottoman Empire, the Jordan system was utilized for small, local irrigation schemes. The Jordan Valley was neglected, but its potential for agricultural development was appreciated by the local bureaucracy. One scheme, suggested in 1913 by Georges Franghia, Director of Public Works in Palestine, proposed to use the Jordan River System for irrigation and electricity. The plan envisaged the diversion of the Yarmuk into Lake Tiberias, a canal with 100 MCM annual flow capacity to irrigate the Jordan Valley, and two power plants to produce electricity.

The collapse of the Ottoman Empire after World War I terminated this project. Serious problems arose when Jewish immigrants started to arrive in large numbers early in the British Mandate. Efforts to estimate the water needs of the local population versus those of the newcomers quickly became a political issue in the debate on Jewish immigration to

Table 1
SUBDIVISIONS AND WATER BALANCE
OF JORDAN RIVER SYSTEM

Source	Country	Flow in million cubic meters		
		Gain	Loss	Total
1. Upper Jordan				
(a) Dan	Israel	245		
(b) Hasbani	Lebanon	138		
(c) Banias	Syria	121		
2. Jordan in Huleh Valley				504
3. Irrigation in Huleh Valley	Israel		-100	
4. Local runoff Huleh to Jisr Banat Yaqub	Israel/Syria	140		
5. Flow into Lake Tiberias				544
6. In Lake Tiberias				
(a) Local runoff	Israel/Syria	70		
(b) Rainfall over Lake	Israel	65		
(c) Springs in and around Lake	Israel	65		
7. Evaporation over Lake Tiberias	Israel		-270	
8. Outflow to lower Jordan				474
9. Yarmuk	Syria/Jordan	492		966
10. Wadis and springs in Ghor	Jordan/Israel	505		1471

Source: Smith (1966), as revised from Main Plan and Hydrological Year-Book of Israel (1946-1960).

Palestine. The question of economic absorptive capacity focussed on the feasibility of large scale Jewish settlement in Palestine.

Table 2 lists the major water surveys and plans for the Jordan River System which were undertaken by the various governments and agencies. A 1920 plan included a survey of the Yarmuk and Jordan Rivers for irrigation and power generation. It was followed in 1922 by a Franco-British agreement which ceded the Mandatory Government the rights to carry out infrastructure work for irrigation. Because of increasing tension between the Arab and Jewish populations, the Mandatory Government did not act upon these plans.

A more ambitious vision was provided by Mavromatis (1922). He proposed an elaborate scheme to irrigate the area around Lake Huleh and drain the swamps, divert the Yarmuk into Lake Tiberias, construct two dams to generate electric power, and build irrigation canals down both banks of the Jordan. Henrique (1928) proposed irrigation of the Yarmuk Triangle.

The first step toward utilization of the system was taken in 1926, when the British High Commissioner for Palestine granted a 70 year concession to a Jewish engineer, Pinhas Rutenberg, to use the Yarmuk and the Jordan to produce hydroelectric power. The High Commissioner had earlier denied such a concession to a Christian Arab. The Rutenberg concession went public as the Palestine Electric Corporation and produced 173 million kwh by 1944. Throughout the Mandate period, the Rutenberg Concession effectively blocked other water usage.

The water issue became more urgent in the 1930s when Jewish immigration to Palestine increased. Immigration was countered by a general strike and widespread Arab rebellion. As indicated in Table 2, the number of plans and surveys increased markedly after the mid-thirties.

Table 2
DEVELOPMENT SCHEMES FOR JORDAN RIVER SYSTEM

<u>Year</u>	<u>Plan</u>	<u>Sponsor</u>
1913	Franghia Plan	Ottoman Empire
1922	Mavromatis Plan	Great Britain
1928	Henriques Report	Great Britain
1935	Palestine Land Development Company	World Zionist Organization
1939	Ionides Survey	Transjordan
1944	Lowdermilk Plan	U.S.A.
1946	Survey of Palestine	Anglo-American Committee of Inquiry
1948	Hays-Savage Plan	World Zionist Organization
1950	MacDonald Report	Jordan
1951	All Israel Plan	Israel
1952	Bunger Plan	Jordan/U.S.A.
1953	Main Plan	UNRWA
1953	Israeli Seven-Year Plan	Israel
1954	Cotton Plan	Israel
1954	Arab Plan	Arab League Technical Committee
1955	Baker-Harza Plan	Jordan
1955	Unified (Johnston) Plan	U.S.A.
1956	Israeli Ten-Year Plan	Israel
1956	Israeli National Water Plan	Israel
1957	Greater Yarmuk Project (East Ghor Canal)	Jordan
1964	Jordan Headwaters Diversion	Arab League

The surveys had a double aim: 1) to estimate the available water resources and 2) to propose methods for optimal use of the Jordan Water System. The schemes failed to generate a common solution, but served to crystallize the main dimensions of the impending conflict.

The Ionides Plan, published in Amman in 1939 by a British employee of the Transjordanian government, for the first time estimated the available water and irrigable land in the Jordan Valley. It supported the Arab claim that the region's water resources were inadequate to sustain a Jewish state. Ionides suggested conservation measures in the side wadis to improve existing irrigation schemes and the diversion of the Yarmuk into a canal down the east side of the Valley to expand irrigation there.

The Lowdermilk Plan, published in 1944, reinforced the Jewish argument that proper water management would generate resources for 4 million Jewish refugees in addition to the nearly 1.8 million Arabs and Jews who were already residing in Palestine. To justify this high estimate of water resources, Lowdermilk included the Litani River in his regional management scheme for a "Jordan Valley Authority" patterned on the Tennessee Valley Authority. He proposed use of Jordan and Litani waters to irrigate the Negev, a canal connecting the Mediterranean and the Great Rift Valley to replenish the Dead Sea and generate power, diversion of the Yarmuk River into Lake Tiberias, and gravity flow canals down the slopes of the Jordan Valley for irrigation.

The Hays-Savage Plan of 1948 was prepared by two American engineers at the request of the World Zionist Organization to provide the engineering details for implementation of the Lowdermilk Plan.

The Palestinian Royal Commission survey of 1936 and the British Colonial Survey (Survey of Palestine) of 1945-46 were more in line with the Arab estimates. The latter was highly skeptical of the Lowdermilk

estimates as well as of the possibility for the cooperation between Arabs and Jews which was deemed necessary for the creation of the "Jordan Valley Authority".

No cooperative solution was found before the influx of Jewish refugees from Europe after World War II changed the parameters of the debate on Palestine. The U.N. partition proposal of 1947, which decided to divide Palestine into Jewish and Arab states, ignored water problems.

The Search for Cooperation: 1948-1955

The 1948 Arab-Israeli war aggravated the difficulties of cooperative water management. For Israel, the new state's boundaries included vast out-basin tracks in the Coastal Plain and arid Negev desert. Israeli plans to use Jordan water for out-basin irrigation were to become a major issue in the conflict. All but one of the headwaters of the Jordan River System were in Arab hands. Strategic territories along the Jordan River Fork, and in the Huleh area, on the eastern shores of Lake Tiberias and at the Jordan-Yarmuk confluence, were either demilitarized "without prejudice as to sovereignty" or disputed by Syria. Concurrently, the Israeli Jewish population more than doubled, from 650,000 in 1948 to 1,600,000 in 1952. Although, because of the Arab exodus, the total number of inhabitants did not rise, the pressure on existing water resources increased significantly. Four factors account for that increase.

First, the mostly European immigrants had different (higher) water consumption habits than the indigenous population.

Second, because of ideological commitment to agriculture out of security/demographic and settler "making the desert bloom" considerations, Israel embarked upon an ambitious plan of agricultural

development. Agricultural settlements provided the most efficient way to settle sparsely populated areas and security zones. A 60-80 family unit (300-400 persons) was a viable agricultural settlement; an urban unit required 600 families (3,000 persons). Most of the new settlements were started by Nahal (the agricultural unit of the IDF [the Israeli Defense Forces] civilian authorities. Jewish irrigated agriculture was more water intensive than traditional Arab agriculture, and agriculture is more water intensive than domestic or industrial usage.

Third, the newly arrived immigrants had few industrial and technical skills. Labor statistics for a 1950 five-year period indicate that only 30 percent of the civilian work force had such skills. Traditional European Jewish skills such as craftsmanship, small entrepreneurship and services could not be utilized in Israel. Agriculture was considered the most efficient way to retrain the new immigrants.

In addition, Israel lacked the industrial infrastructure on which urban development is contingent. Most industrial establishments in Palestine were small. In 1943 the bulk (73.1 percent) of such establishments employed between 5-24 persons. Only 3.8 percent employed between 50-99 persons, and 3.7 percent employed 100-299 persons. The cost of the 1948 war and the absorption of immigrants plunged Israel into an economic crisis that permitted no investment in industrial infrastructure. The austerity program and food rationing only ended in 1955.

Jordan, in 1948, was too overburdened to undertake water projects. Out of the 750,000-900,000 Palestinians who fled or were expelled from the areas of Palestine that became the State of Israel, some 450,000 went to Transjordan and the West Bank (which merged in 1950 into the Hashemite Kingdom of Jordan). Together with the 460,000 Palestinians who had

previously lived on the West Bank. This influx increased the population of Jordan by 80 percent -- to 1,850,000. Since most of the refugees had been peasants and agricultural workers, only agriculture posed the possibility for rehabilitation without extensive retraining. This strained the land productivity of one of the poorest of the Arab states.

The dislocation of the 1948 war was compounded for Jordan by its lack of development. Reports of the U.S. Foreign Operation Administration in the early 1950s characterized Jordan as deficient in central administration, with fragmentary educational systems and little health care. The pre-war transport networks in both the East and West Bank had been directed west toward Haifa. With access to that port closed, Jordan had to develop a north-south transport system. Per capita GNP was less than \$100 per year, and there was virtually no industrial infrastructure. Unemployment, malnutrition, and disease were rife.

Most of the influx of refugees settled in the West Bank in refugee camps around existing urban centers. This necessitated hasty residential construction. The United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) was of moderate assistance in dealing with immediate problems.

Long-term rehabilitation of the refugees could only be linked to the overall development of agriculture in Jordan. Prospects seemed unpromising. Only 10 percent of the total area of Jordan was deemed cultivable. A large part of this land, especially in the West Bank, was of low quality and eroding. Most agriculture was rainfed, although in large parts of the cultivated area the average annual rainfall was below 40.64 cm. Only the northern hills in the East and West Bank received more per year.

The only alternative round to increased cultivation was transition to irrigation agriculture, but possibilities were limited. The only sizeable perennial surface water source was the Jordan River and its tributaries. Inexpensive gravity-flow irrigation was applicable only in the low lying Jordan Rift Valley. Diversion to the hills and plateaus, wheremost of the cultivated land was located, would have involved expensive pumping.

At the end of the 1940s only a few limited water projects had been carried out. They included earthen irrigation channels off the Jordan, and concrete irrigation channels along the side wadis. The projects were uncoordinated. The Department of Irrigation and Hydroelectric Power was formed only in 1954.

The fragile armistice agreements signed by the Arab states and Israel in 1949 did not deal with water, nor was the post-war atmosphere conducive to negotiation. In consequence, each of the riparians moved to utilize the Jordan River System unilaterally.

Israel resumed water planning immediately after 1948. The comprehensive All Israel Plan was completed in 1951. It included the draining of the Huleh swamp, the diversion of the Jordan River, and the construction of a carrier system. Subsequently consolidated into the National Water Carrier, this plan was to become the keystone of Israel's water development diverting the Jordan waters to the Coastal Plains and the Negev Desert.

The first part of the project, the draining of the Huleh swamps, began in 1951. Israel delayed construction of the first leg of the Carrier for foreign policy reasons. Work on the Huleh swamp, which infringed on the demilitarized zone with Syria, provoked a number of military incidents. The incidents took the form of conflict between Israel

and Syria and between Israeli and Arab residents in disputed territories and demilitarized zones, some designed to harass and remove unwanted population elements or protect what was viewed as personal property, other incidents intended to interfere with development of water resources in ways that the contesting party viewed as contrary to its interests. In some cases, over a period of some two decades, water-related actions were used as a mask for other conflicts (such as shooting on Lake Tiberias in 1954-55 that was escalated to incursions that took hostages to exchange for prisoners of war held by the other side.) Throughout the period, incidents threatened to shatter the Armistice Agreements. Some analysts have held that water was a major factor leading to the 1967 war.

Jisr Banat Yaqub, the targeted diversion point for the large-scale Israeli project, was located in the demilitarized zone between Israel and Syria. Israel was apprehensive that this fact would provoke Arab opposition and international condemnation. It delayed the decision to proceed with the larger diversion scheme until July 1953.

By the early 1950s, both the Jordanian government and UNRWA were working on irrigation schemes to improve Jordanian agriculture and resettle the Palestinian refugees. In 1950, Jordan received a commissioned study from British consultant Sir Murdoch MacDonald which proposed diverting the Yarmuk into Lake Tiberias and constructing irrigation canals down both sides of the Jordan Valley. A 1952 plan for UNRWA by American engineer M.E. Bungler envisaged a dam on the Yarmuk River at Maqarin with storage capacity of 480 MCM. The impounded water would be diverted by a second dam at Addassiyah into gravity-flow canals along the East Ghor of the Jordan Valley. Bungler reckoned the work would irrigate 435,000 dunums in Jordan and 60,000 dunums in Syria. Hydroelectric plants at the

two dams would generate 28,300 kwh per year for Jordan and Syria. Experts estimated the Bunger Plan would settle 100,000 people.

In March 1953, Jordan and UNRWA signed an agreement to execute the Bunger Plan. In June 1953, Jordan and Syria agreed on sharing the Yarmuk water. The actual work on the project began in July 1953. However, even before it commenced, Israel protested that its riparian rights to the Yarmuk were not recognized in the Bunger Plan. The Yarmuk Triangle demilitarized zone controlled by Israel only had ten kilometers frontage on the Yarmuk.

Israel, in July 1953, commenced the diversion of the Jordan at Jisr Banat Yaqub. This site was in the demilitarized zone, but had two technical advantages over lower alternative sites: 1) it had a lower salinity level than points further down the Jordan River Fork; 2) the 270 m drop in elevation between the site and Lake Tiberias was enough to use gravitation as the means of diversion. The Israeli Government underestimated both Syrian and international reaction. In September 1953, the Syrians protested to the United Nations. Unlike in the Huleh drainage case, which the U.N. had countenanced, the U.N. ruled in favor of Syria. Israel ignored the order to discontinue work. Only an American threat in November 1953 to cut off funds channeled to Israel by the Foreign Operation Administration convinced Israel to terminate construction. Subsequently, a point at Eshod Kinrot on Lake Tiberias was chosen. It was technically inferior to the original site; water salinity was higher and hydroelectric power had to be used to pump the water to the Carrier.

Meanwhile, the Jordanians had to abandon the Bunger Plan entirely. One factor was Israel's objection on the ground that the original Rutenberg concession gave Israel rights to the Yarmuk. Another factor was a change in American perceptions. King Hussein, in his autobiography,

alleges that the United States accepted the Israeli legal position and hence denied funding to the Bunker plan.

The U.S. Government then moved toward deeper involvement. On October 16, 1953, President Eisenhower appointed Eric Johnston as a special ambassador to mediate a comprehensive plan for regional development of the Jordan River System. Philosophically based on the Marshall Plan in Europe, it sought to reduce the conflict potential of the region by promoting cooperation and economic stability.

The large number of plans issued between 1953 and 1955 (Table 2) represent bargaining stages in the negotiation over the sharing of the Jordan River System. The major bargaining issues pertained to: 1) the water quotas for the riparians, (2) the use of Lake Tiberias as a storage facility, (3) the use of Jordan waters for out-of-basin areas, (4) the use of the Litani as part of the system, (5) the nature of international supervision and guarantees.

The 'base plan' for Johnston's mission was an UNRWA-sponsored report prepared by Charles T. Main, done under the supervision of the TVA with the backing of the American State Department. The plan featured:

- (1) a dam on the Hasbani to provide power and irrigate the Galilee area;
- (2) dams on the Dan and Banyas rivers to irrigate the Galilee;
- (3) drainage of the Huleh swamps;
- (4) a dam at Maqarin with 175 MCM storage capacity for power generation;
- (5) a dam at Addassiyah to divert water to Lake Tiberias and into the East Ghor area;

- (6) a small dam at the outlet to Lake Tiberias to increase storage capacity;
- (7) gravity-flow canals down the east and west sides of the Jordan Valley to irrigate the area between the Yarmuk and the Dead Sea;
- (8) control works and canals to utilize perennial flows from the wadis.

The Main Plan favored primary in-basin use of the Jordan waters and ruled out integration of the Litani. Provisional quotas gave Israel 394 MCM, Jordan 774 MCM, and Syria 45 MCM.

Israel opened the bargaining by publishing a seven-year plan. Its major features, modelled after the Lowdermilk and Hayes plans, included the integration of the Litani, the use of Lake Tiberias as the main storage facility, out-of-basin use of the Jordan waters, and the Mediterranean-Dead Sea canal. Since water flow was based on the combined Jordan-Litani output of 2,500 MCM, Israel sought an initial quota of 810 MCM.

The Israeli proposals were elaborated in the plan prepared for it by Joseph Cotton in 1954. The combined Litani-Jordan water resources were estimated at 2,345.7 MCM. Israel was to receive 1,290 MCM. The Arab share of 1,055.7 MCM was to be divided by allocating 575 MCM to Jordan, 450.7 MCM to Lebanon and 30 MCM to Syria.

The Arabs responded to the Main 'base plan' with the Arab Plan of 1954. It reaffirmed the Ionides, MacDonald and Bungier principle of exclusive in-basin use of the water, rejected storage in Lake Tiberias, and rejected integration of the Litani. Because 75 percent of the water of the Jordan water system originates in Arab countries, it objected to the quota allocations proposed in the Main Plan. According to the Arab proposal, Israel was to get 200 MCM, Jordan 861 MCM, and Syria 132 MCM.

The Arab plan recognized Lebanon as a riparian of the Jordan River System and allocated it 35 MCM.

The Baker-Harza study was published in 1955. The American engineers were commissioned by the Jordanian Government to conduct a hydrological survey to determine the amount of water needed to irrigate the Jordan Valley. The Plan was technically oriented and not directly related to the negotiations. It recommended construction of an elaborate canal system to irrigate 460,000 dunums in the Jordan Valley. It increased the estimate of cultivable land but decreased the water duty (the amount of water required per unit of land to produce crops).

As negotiations progressed, disagreements were gradually reduced. Israel gave up on integration of the Litani, the Arabs removed their objection to out-of-basin use of waters. Lake Tiberias was rejected by the Arabs as a reservoir for Yarmuk water. An alternative Arab proposal to treat Lake Tiberias (without diversion of the Yarmuk) as a regional storage center to benefit all riparians was rejected by Israel. The Arabs demanded and Israel opposed international supervision.

Allocation of water quotas was the most difficult issue. As illustrated in Table 3, the disparity between the opening demands was considerable. After the claim for the Litani was dropped, Israel downgraded its quota demand to 550 MCM. After extremely hard bargaining, the so-called "Gardiner Formula" was adopted as the final version of the Unified (Johnston) Plan (Table 3). Compared to the Main Plan figures, the Johnston Plan quotas are significantly different only with regard to Syria and Lebanon. Jordan's share was slightly scaled down and Israel was to receive the variable residue after other quotas had been met; most estimates place the average residue at 400 MCM, although some put it as high as 450 MCM.

Table 3
WATER ALLOCATIONS TO RIPARIANS
OF JORDAN RIVER SYSTEM

(in million cubic meters)

Plan/Source	Lebanon	Syria	Jordan	Israel	Total
Main Plan	nil	45	774	394	1213
Arab Plan	35	132	698	182	1047
Cotton Plan	450.7	30	575	1290	2345.7
Unified (Johnston) Plan					
Hasbani	35				35
Banias		20			20
Jordan (main stream)		22	100	375*	497*
Yarmuk		90	377	25	492
Side wadis			243		243
Total Unified Plan	35	132	720	400*	1287*

Note: The Cotton Plan included the Litani as part of the Jordan River System. Different plans allocated different amounts in accordance with differing estimates of the resources of the system. One major variable in the reporting of the planned allocations is the amount of ground water included in the estimates.

* According to the compromise "Gardiner Formula," the share of Israel from the main stream of the Jordan was defined as the "residue" after the other co-riparians had received their shares. This would vary from year to year, but was expected to average 375 MCM.

The Unified Plan stipulated that supervision would be exercised by a three-member Neutral Engineering Board. The Board's mandate included the supervision of water withdrawal, record keeping, and preventing the construction of projects which would deviate from the spirit and letter of the agreement.

The Unified Plan was accepted by the technical committees from both Israel and the Arab League. The Israeli Cabinet discussed the Plan in July 1955 without taking a vote. The Arab Experts Committee approved the Plan in September 1955 and referred it for final approval to the Arab League Council. The Council decided on October 11, 1955 not to ratify the Plan. According to most observers, including Johnston himself, the Arab non-adoption of the Plan was not total rejection; while they failed to approve it politically, they were apparently determined to adhere to the technical details. The issue of impartial monitoring was not resolved, which made for problems in the future.

Unilateral Implementation: 1955-1967

The failure to develop a multilateral approach to water management reinforced unilateral development. Though the Unified Plan failed to be ratified, both Jordan and Israel undertook to operate within their allocations. The two major projects undertaken were the Israeli National Water Carrier and Jordan's East Ghor Canal.

The National Water Carrier diverted water from the Jordan River Fork at Eshed Kinrot to the Coastal Plain and the Negev desert. Although sections of it were begun before 1955, it was only completed in 1964. The initial diversion capacity of the National Water Carrier without

supplementary booster pumps was 320 MCM, well within the limits of the Johnston Plan.

Design of the East Ghor Canal was begun by Jordan in 1957. It was intended as the first section of a much more ambitious plan known as the Greater Yarmuk Project. Additional sections included: 1) construction of two dams on the Yarmuk (Mukheiba and Maqarin) for storage and hydroelectricity; 2) construction of a 47-km West Ghor Canal together with a siphon across the Jordan River near Wadi Faria to connect it with the East Ghor Canal; 3) construction of seven dams to utilize seasonal flow on side wadis flowing into the Jordan; 4) construction of pumping stations, lateral canals, and flood protection and drainage facilities.

In the original Greater Yarmuk Project, the East Ghor Canal was scheduled to provide only 25 percent of the total irrigation scheme. Construction of the Canal started in 1959. By 1961 its first section was completed; sections two and three, down to the Wadi Zarqa, were in service by June 1966.

Shortly before completion of the Israeli Water Carrier in 1964, an Arab summit conference decided to try to thwart it. Discarding direct military attack, the Arab states chose to divert the Jordan headwaters. Two options were considered: either the diversion of the Hasbani to the Litani and the diversion of the Baniyas to the Yarmuk; or the diversion of both the Hasbani and the Baniyas to the Yarmuk. The diverted waters were to be stored behind the Mukheiba Dam.

According to neutral assessments, the scheme was only marginally feasible. Because of soil porosity and other obstacles, it was technically difficult and expensive. Its estimated cost was between \$190-\$200 million, comparable to the cost of the entire Israeli National Water

Carrier. Financial issues were to be solved by contributions from Saudi Arabia and Egypt.

Political considerations cited by the Arabs in rejecting the 1955 Johnston Plan were revived to justify the diversion scheme. A particular emphasis was placed on the Carrier's capability to enhance Israel's capacity to absorb immigrants to the detriment of Palestinian refugees. In response, Israel stressed that the National Water Carrier was within the limits of the Johnston Plan. It declared that, as a sovereign state, it had the right to set immigration policies without external interference, and refused to make concessions regarding Arab refugees.

The Arabs started work on the Headwater Diversion in 1965. Israel declared that it would regard such diversion as an infringement of its sovereign rights. According to estimates, the completion of the Headwater Diversion Project would have deprived Israel of 35 percent of its contemplated withdrawal from the Upper Jordan, halving Israel's supply for the Carrier.

In a series of military strikes, Israel hit the diversion work culminating in April 1967 in air strikes deep inside Syria. The increase in water-related Arab-Israeli hostility was major factor leading to the 1967 June War.

The Militarization of the Water Conflict: 1967-1971.

The 1967 war increased the trend towards competitive unilateral utilization of the Jordan River system.

Israel improved its hydrostrategic position through the occupation of the Golan Heights and the West Bank. The occupation of the Golan Heights made it impossible for the Arab states to divert the Jordan

Headwaters. The 1967 ceasefire lines gave Israel control of half the length of the Yarmuk River compared to 10 km before the war. This made development of the Yarmuk contingent upon Israeli consent. Even small-scale unilateral impoundment by Jordan can easily be detected by Israel and attacked militarily.

The ability of Arab riparians to proceed with unilateral schemes decreased in proportion to Israeli gains. When the war started, about 20 percent of the Greater Yarmuk Project was completed. In the wake of the war, the two most important projects, the Mukheiba and Maqarin Dams, had to be abandoned. The Mukheiba Dam had been planned to store 200 MCM of water and Maqarin Dam to store up to 350 MCM and manufacture 25,000 kwh of electricity annually.

When the Palestine Liberation Organization (PLO) emerged under new leadership after the 1967 War, it mounted an intensive campaign against Israeli settlements in the Jordan Valley. This peaked in the 1968-69 period. It included raids against water installations, such as that on the Naharaim pumping station in the summer of 1969. The Israeli-PLO skirmishes soon deteriorated into Israeli conflict with Jordanian and Iraqi detachments stationed in the East Jordan Valley.

Israel initially refrained from damaging the East Ghor Canal. After unsuccessful military efforts to stop PLO activities which resulted in scores of casualties, the Israeli cabinet revised this policy in June 1969. Israeli raids on June 23, 1969 and August 10, 1969 put most of the East Ghor Canal out of commission. According to Jordan, the Canal was out of order four times between 1967 and 1971. Israel conjectured that extensive damage to irrigation would pressure King Hussein to act against the PLO.

Although the major reason for Israeli action against the East Ghor Canal was strategic, the summer 1969 action may also have been prompted by water-related concerns. According to measurements in April-May 1969 by Israeli water authorities, the level of the Jordan fell 27 inches from its average base for this period. The initial Israeli assumption was that the Jordanians were overdrawing their quota. Intensive technical and diplomatic activity involving the United States, Jordan and Israel eventually made it clear that the unprecedented decrease in water level was caused by natural factors, pointing again to the need for an impartial water monitor.

Conflict over the East Ghor Canal was mediated by the United States. After secret negotiations in 1969-1970, Jordan was allowed to repair the Canal; in exchange Jordan reaffirmed its adherence to Johnston plan quotas and pledged to terminate PLO activity in Jordan. King Hussein expelled the PLO from Jordan in 1970-1971.

The Return to Unilateral Implementation: 1971-1983

While the secret Israeli-Jordanian agreement removed a present danger, it did little to improve cooperation. A perception of mutual interest eased occasional frictions. An Israeli complaint of Jordanian overuse, following the construction in 1975 of a small auxiliary dam on the Yarmuk, was resolved amicably; occasional Jordanian complaints have also been resolved. Secrecy surrounded all negotiations.

Interest in the Maqarin Dam was renewed in the mid-1970s, when the Jordan Valley Authority proposed to build the \$600-800 million project on the Yarmuk River. By this plan, the Maqarin Dam would store 350 MCM of water, its two power plants would generate 46 million kwh of electricity.

Negotiations for Israeli consent were mediated by America's Philip Habib. Although few details about the negotiations are available, an Israeli demand for a larger share of Yarmuk waters was reputedly discussed and Israeli threats of pressure on U.S. and World Bank funding sources were bruited in the press. It is unclear whether Syria ever consented. Work is presently at a standstill.

The water needs of both Israel and Jordan are severe. Water shortages became particularly acute in the fall of 1973, following a series of dry years, when the underground water reserves in Israel dropped from 2,500 MCM to 150 MCM. The Israeli government made plans to cut back water for agriculture 10%; only the heavy winter rains of 1973-74 forestalled this necessity.

Throughout the 1970s, the Israeli government embarked on several projects aimed at increasing the amount of available water, utilizing water more efficiently, and expanding the area of cultivation. In a continuation of the Huleh Valley project of the 1950s, more drainage pipes and canals were laid, aimed at reducing flooding by lowering the water level of the Jordan River to facilitate faster drainage of storm runoff. An unanticipated side effect was the increase in the flow of nutrients to Lake Tiberias, raising the possibility of contamination in an area used for both drinking water and recreation. The nearby Dan Project in the upper Huleh Valley, begun in the early 1970s, was projected to salvage 130 MCM/yr in reclaimed sewage water by 2000.

Another project was located in the Arava, the Rift Valley south of the Dead Sea. This was an area previously considered too arid for cultivation. Utilizing greenhouses and drip irrigation -- a technique developed experimentally in Israel -- the Arava farms specialize in production of winter flowers and produce using previously untapped underground

water. However, water use in the area is high: 220 m³ per person per day as compared to 141 m³ per person per day in other Israeli settlements of comparable size.

Despite these efforts, Israel is at present utilizing about 95 percent of its water resources. A major outcome of this situation has been a growing tendency in Israel to overuse the underground water resources. Out of Israel's total annual water consumption of 1700 MCM, 30 percent comes from the Jordan River system. The rest is supplied by rain catchment and underground water. Because of intensive use, the Coastal Plain aquifer is in danger of contamination by sea water. Forty percent of Israel's present water consumption derives from outside the Green Line.

Israel's situation was partially alleviated by the 1967 occupation of the Golan Heights and the West Bank. Golan Heights resources are limited: 80 percent of its consumption comes from Lake Tiberias, the remaining 20 percent is collected locally through catchment techniques. Israel is transferring water from the water-rich north to the arid south of the Golan Heights to provide water for settlements to cultivate 36,000 dunams using 54 MCM of water annually. By 1980, water usage in the Golan Heights was ten times what it had been before 1967 although the population was a fraction of its former size.

The West Bank is more critical to Israel's water supply. The two aquifers which provide most of the underground water within the Green Line rise in the West Bank. Natural replenishment of the whole aquifer is estimated at 560-670 MCM. Most of it, approximately 450 MCM, drains westward in Israel.

The amount of underground water in the West Bank is disputed. Israeli sources claim that West Bank annual water resources amount to about 120 MCM, equivalent to the current annual consumption level. Jordanian sources claim there is a 630-775 MCM surplus on the West Bank.

According to the West Bank and Gaza Data Base Project, annual water consumption in the West Bank is 100 MCM. Out of this, 14 MCM is for domestic use and the rest is used to irrigate 100,000 dunums of land. Per capita domestic consumption in the West Bank is considerably lower than in Israel. Urban populations in the West Bank use 22 m³ a year vs. 165 m³ for urban populations in Israel. Rural populations in the West Bank use 7 m³ a year compared to 22 m³ for Arab villages in Israel.

Israel, through its occupation administration, has imposed stringent conservation measures on the Arab population. The only envisaged increase in water consumption is domestic (to 30 m³ per capita). Conservation measures are applied rigorously to Arab agriculture. At present only 5 percent (100,000 dunums) of Arab land is irrigated.

Drilling of artesian wells is licensed by the Israeli Water Commission. The number of annual permits is limited. Pumping from wells is monitored by meters, with penalties for overpumping. According to a Jordanian report, in 1977 the 88 Arab wells in the Jordan Valley were limited to 9.9 MCM; the 17 Jewish wells were allowed 17 MCM. There are also reports that wells drilled by Israeli settlers affect the flow of neighboring Arab wells, lowering the water table or drying them up.

The growth of Jewish settlements in the West Bank has aggravated water problems. Most of the water used by Jewish settlers is for irrigation. In the Jordan Valley, Jewish settlements use 25 MCM for irrigation of 20-30,000 dunums of land. This is planned to increase to 40 MCM by the late 1980s to irrigate 40-50,000 dunams. Jewish domestic consumption

in the West Bank amounts to only 1-2 MCM annually. According to projections by the West Bank Data Project, an increase of urban Jewish population would have only marginal impact on water consumption, but an increase in agricultural settlements would exacerbate the water situation.

The Israeli water regime has prevented the development of Arab agriculture in the West Bank. According to Arab sources and Stauffer allowing indigenous development would deny Israel of 12 percent of its total annual supply. The same sources estimate that 600-700 MCM (almost 40 percent of Israel's annual water consumption) comes from sources outside the 1967 border. If this is correct, then almost the whole increase in Israel's water consumption since 1967 has been sustained by the territorial expansion.

There are indications that this amount is becoming inadequate to meet Israeli needs. The Israeli Water Commission announced in October 1983 that it will not supply water for Jewish agricultural use in the West Bank out of local resources. Arab irrigation will be closely monitored, but domestic supplies for Arabs will not be impaired. It is not clear whether plans to increase Arab domestic supplies will be cancelled. These steps indicate Israeli fears that the Coastal Plain aquifers stand in danger of saline contamination.

The Hashemite Kingdom of Jordan suffered enormous dislocation following the 1967 war. The West Bank, though only 6 percent of Jordan's territory and 25 percent of the cultivated area, accounted for 45 percent of its GNP. The influx of some 300,000 new refugees from the West Bank imposed an additional burden on the economy.

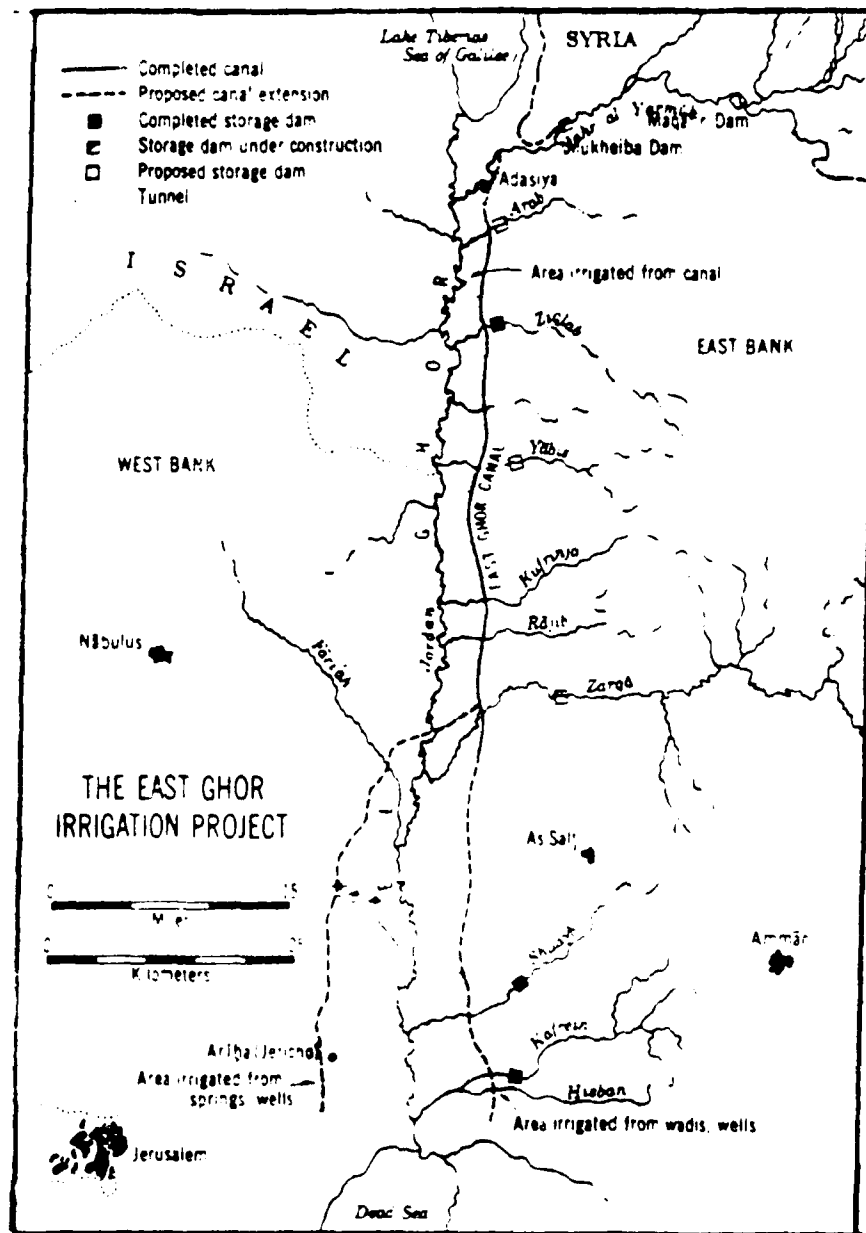
Damage to the East Ghor Canal and fighting in the region from 1968 to 1970 set back agriculture in the Jordan Valley. Most of the Valley's

approximately 60,000 inhabitants fled. Valley agricultural production, which had nearly doubled between 1959 and 1965, was severely reduced. In 1967 the share of agriculture in Jordan's GNP (exclusive of West Bank) was 25.2 million J.D.; in 1970 it dropped to 15.6 million J.D. Despite rescue efforts by the National Resource Authority, the Canal started silting up.

In 1972, Crown Prince Hassan issued a Plan for the Rehabilitation and Development of the Jordan Vally. The Plan identified the major problems affecting development of water resources in Jordan: 1) poor coordination between various ministries; 2) paucity of detailed feasibility studies to attract investors; 3) irregularities in awarding contracts.

The Jordan Valley Commission (later the Jordan Valley Authority) reviewed unfinished water projects and charted the future course. Its Seven-Year Report for 1975-82 was published in 1974. The guiding principle of the plan was to concentrate on development of the Yarmuk. Its main features included:

- (1) The Maqarin Dam. Its initial capacity of 150 MCM was to be raised to 350 MCM or even 550 MCM. A 24-km carrier canal would deliver water to the East Ghor Canal to irrigate an additional 125,000 dunums. Two power plants would provide 46 million kwh.
- (2) The King Talal Dam on the Zarqa River, with a storage capacity of 48 MCM and a 18 km extension of the East Ghor Canal. The King Talal Dam was completed in 1977 at a cost of \$46 million.
- (3) Smaller projects in the side wadis: dams regulating the flow of the Wadi Ziqlab were to be completed by 1985; the Kufrein Dam was built in 1980.



- (4) Subsurface drainage, with perforated pipes to prevent salination. Drained water, monitored for quality, will be reused for irrigation if not too salty.

Projected costs (exclusive of the Maqarin Dam complex) were approximately \$105.4 million, though experience showed cost overruns could be expected. The projects were financed by a variety of sources, among them Arab states, USAID, the World Bank, and European governments.

The water shortage in Jordan is most noticeable in domestic use. Amman, whose supply comes from artesian reservoirs which provide only 16-17 MCM a year, is the hardest hit. Domestic supplies are pumped only once a week; one source estimates that Amman is undersupplied by 50 percent. Demand is expected to rise by a factor of five in the next 10 years. Plans to alleviate the shortage include diverting 12-14 MCM a year from the King Talal Dam, and piping water from Azraq oasis (100 km away). Long-term solution of the problem is seen as contingent on the construction of the Maqarin Dam. Although the Maqarin water is designated for irrigation, the JVA is being pressured to pump part of the water to Amman.

Industrial development has not been affected yet by the shortage of water, but Najmeedin al-Dajani, the Minister of Industry and Trade, says conservation measures are considered. One option would be to provide industry with brackish or recycled water unfit for domestic use.

Water is especially crucial for agriculture. Population increases after 1948 and 1967 required increased food production, which extended cropping into marginal land. According to a 1979 report, five percent of Jordan's 91 million dunums (excluding the West Bank) are cultivable. Of the 4.5 million dunums of cultivable land, 181,533 dunums of land are cultivated in the Jordan Valley; of this, 174,979 dunums are irrigated.

The East Ghor Canal irrigates 65.5 percent, side wadis irrigate 16.2 percent, underground wells irrigate 8.2 percent, water pumped from the Jordan irrigates 0.9 percent, and 9.2 percent is rainfed. Completion of the Maqarin Dam would add 125,000 dunums to the irrigated area in the Valley. The Jordan Valley Authority is also introducing water saving techniques - drip irrigation, row tunnels, sprinkler/drip combination, plasticulture - to increase agricultural efficiency.

TECHNICAL ASPECTS OF THE JORDAN RIVER SYSTEM

Water Quality

The headwaters of the Jordan are generally high quality waters. Considering first the three tributaries of the Upper Jordan (Jordan Fork), the Dan, Hasbani and Baniyas, each is seen to have a salinity of about 20 ppm. This is clearly sufficient to satisfy agricultural, domestic and most industrial uses. Hence, the quality of the Upper Jordan as it enters Lake Tiberias is quite desirable in terms of salinity. The salinity of the Yarmuk River is also reasonably low, reported as 100 ppm. The salinity of the lower portion of the Jordan River System becomes progressively greater below the entry of the Upper Jordan into Lake Tiberias.

A number of natural sources render Lake Tiberias water saline to the extent of about 250 ppm which is too high for some sensitive crops, most notably the citrus fruits which are economically important in this region. Much of the salt results from the inflow of salty subterranean springs. (As noted below, considerable Israeli effort has been devoted to reducing the level of salinity in Lake Tiberias. Current levels of salinity in Lake Tiberias are about 340 ppm which is marginal for superior irrigation water.) As the Jordan proceeds down into the Rift Valley toward the Dead Sea it becomes saltier, reaching several thousand parts per million by the Allenby Bridge near Jericho. Ultimately, the salinity of the Jordan River System reaches 25 percent (250,000 ppm) in the Dead Sea, a level approximately seven times that of the ocean. This is too high to support plant or animal life, although certain minerals.

especially bromines and potash, can be extracted by (solar) evaporative processes.

The development of the water resources of the Jordan have accentuated the salinity of the Lower Jordan. The salinity in the lower reaches of the river has increased in recent years as a result of the diversion of the low salinity headwaters both to the National Water Carrier and to the East Ghor Canal.

Although the greatest water quality concern in this region is salinity and its impact on the agricultural fitness of the water, there is some recent concern with other water quality issues. The first of these is domestic pollution of the Upper Jordan which may eventually threaten the National Water Carrier. Additionally, the draining of the Huleh Valley has increased nutrient flows into Lake Tiberias and has resulted in a heightened concern with eutrophication in that basin

Water Development Plans

Water has played an important part in plans for development and stability in the Middle East. A number of such plans were developed during the 1940s and 1950s. The most important of these as mentioned above was the Johnston Plan. In a number of respects, this plan represents a compromise and can be seen as an outgrowth of several earlier plans which are summarized below.

The Lowdermilk Plan, and the Hays-Savage Plan of 1948, the MacDonald Report, and the Burger Plan were forerunners to the TVA Plan or Main Plan (Charles T. Main, Inc., 1953). This plan took its name from its drafter, Charles T. Main, Inc., and from the role of the Tennessee Valley Authority in developing the plan. The Main Plan became the basis of the

Johnston Plan, a series of compromises which grew out of the Main Plan and separate plans drawn up by Israel and Jordan and were negotiated among the parties by U.S. Special Ambassador Eric Johnston. The result, known as the Unified Water Plan, called for about 60 percent of the water to be available to the three Arab states and 40 percent to Israel. Though rejected for political reasons, the technical aspects were subsequently used as the basis of water planning by all parties.

For Israel, the implementation of water works took the form of the construction of the National Water Carrier, an extensive conduit system designed to transport water from the water-rich (at least 100 MCM/yr) north to the potentially fertile but arid (30-200 MCM/yr) out-of-basin regions of the Negev Desert. The Carrier, completed in 1964, lies entirely within Israel's pre-1967 boundaries and diverts water from the Jordan at the northern edge of Lake Tiberias along the coast to the Negev.

The Yarqon-Negev part of the National Water Carrier system, completed in 1955, is fed by wells east of Tel Aviv and provides 270 MCM for that city and for irrigating the Lachish area. Another portion of the system is used to collect water from northern Galilean creeks which was formerly discharged to the Mediterranean and to irrigate portions of the Esdraelon Valley. A third part of the system drained marshy areas (Huleh Valley) in an effort to improve the flow to the Upper Jordan. These three parts of the overall system were completed early and are often not considered to be part of the National Water Carrier proper.

The Carrier consists of a series of pumps, canals, and tunnels used to convey water taken from Eshed Kinrot on Lake Tiberias (below sea level) to as far as 200 km to the south. The average water flow is 320 MCM per year and the elevation change is 210 m. As an adjunct to the

Carrier, work has been undertaken to reduce the saline inputs to Lake Tiberias in an effort to reduce the salinity in that lake which serves as a reservoir for the National Water Carrier. Projections are that the salinity of Lake Tiberias will eventually be reduced to about 130 ppm.

Other Israeli development has included drainage and canalization work in the Huleh Valley to control runoff and flooding in the area. A program of irrigation has been undertaken in the Golan Heights; by 1980 this involved the use of 22 MCM per year for the irrigation of 6500 hectares. This water came from developing local resources and by drawing water from Lake Tiberias.

In recent years, the much-discussed Mediterranean-Dead Sea Canal was again suggested. The fundamental premise behind this project is that a means must be found to keep the level of the Dead Sea stable. With the continued exploitation of the Jordan River, the level of the Dead Sea has dropped over the past ten to twenty years. As proposed by the Israelis in 1980, the plan to link the two seas would exploit the 400 m elevation difference between them by including hydroelectric stations totalling 600 MW. In addition, proposals were made to use the water for cooling nuclear power stations rated at 1800 MW, and to investigate the feasibility of generating 1500 MW for solar ponds. The Canal would be 72 km long, including a 32 km section which would be open and a 40 km tunnel. The first 12.5 km would traverse occupied territory in the southern Gaza Strip. The quantity of water involved is estimated to be 750 MCM per year, a figure in close agreement with the 990 MCM annually projected by Main. The project will be expensive, and one observer has suggested that a military solution (i.e., a strike against the diversion facilities on the Yarmuk) to the problem of the Dead Sea elevation would be more

economical. An annual flow of 725 MCM would increase the level of the Dead Sea and this is expected to have an adverse effect on Jordanian industrialization along the shore of the Dead Sea.

Given the finite supply of water resources and the increasing demand for water in Israel, attention has also focussed on alternative technical options for increasing water availability. These include large-scale desalination which is still considered too costly; conservation in terms of irrigation and domestic and industrial usage; and increasing the potential of available water supply from artificial and natural sources. The latter two include options such as further development of groundwater supplies, storm water interception, sewage reclamation, cloud seeding and small-scale desalination. Some observers hold that the most promising technical alternative is sewage reclamation. One analyst estimates that as much as 200 MCM per year can be recycled by 1985, while another states 130 MCM will be available by the year 2000. However, there are a number of technical and sanitary ramifications to sewage reclamation which are only now being examined.

One final note concerning Israeli plans and future water development concerns the potential for conservation. Historically, a key policy followed by Israel was the extravagant use of water as part of the plan to develop the desert. There is evidence, presented by Galnoor, that the agricultural demand for water had decreased from a high of 0.85 MCM per thousand dunums in 1955 to 0.71 in 1975. Other reports indicate that use of drip and trickle irrigation methods is spreading in Israel.

The development undertaken by the Jordanians has involved cooperative efforts with the Syrians. The Jordanian Great Yarmuk Project was undertaken at the same time as the Israeli's National Water Carrier. According to Garbell, it is most meaningful to view the Great Yarmuk

Project in three phases. The first phase was a headwater irrigation program designed to provide controlled winter irrigation and expanded summer irrigation in the El-Muzeirib region of Syria. The Upper East Ghor Canal phase was completed in 1964, and, by 1979, it had reached a length of 100 km; a further expansion has been planned to bring it adjacent to the Dead Sea. The Maqarin Dam phase involves the construction of a dam at Maqarin on the Jordan-Syria border approximately 35 km east of the confluence of the Yarmuk River and the Jordan. The Mukheiba Dam was to be located about 10 km east of the Yarmuk-Jordan confluence.

Water Consumption

The primary users of the waters of the Jordan are Israel and Jordan. Between them, the Jordan River System has been extensively exploited and this river satisfies about one-half of their water demand. The other riparian states are Lebanon and Syria; their use of the Jordan at present is minor in comparison to that of the others, and satisfies about 5 percent of their total demand for water. The current estimate for the total annual demand for water by Israel is about 1750 MCM, approximately 80 percent of which is used for irrigation, 15 percent for domestic use, and 5 percent for industrial use. Approximately 43 percent of the cultivated land is irrigated. This amounts to 1.85 million dunums. Present estimates indicate that Israel presently uses as much as 95 percent of the total renewable water resource available to it. Galnoor states that the total stock of sustainable water yield in Israel is 1500-1600 MCM per year. This represents an extremely high degree of utilization of water resources. Israeli per capita consumption (537 m^3 per year; 86 m^3 per

year for domestic purposes only) is not out of line compared to other industrialized nations, although it is high compared to its neighbors. The occupied lands, most notably the West Bank and Golan Heights, are important in the water economy of Israel. Control of the Golan Heights prevents any Arab attempt to divert the Jordan headwaters as threatened in 1964.

The role of the West Bank in the water economy of Israel is worth comment. It is estimated that one-third of Israel's water requirement originates in rainfall over the western slopes of the West Bank and is drawn from the same aquifer system that supplies the West Bank. Hence, during the post-1967 period, the Israeli occupation of the West Bank has allowed greater exploitation of this aquifer by preventing new hydrologic development by the Arab population. The effect is to maximize groundwater recharge so that the aquifer under Israel may be more extensively developed. At the same time, Israeli settlements in the West Bank are tapping the aquifer.

It should also be noted that another one-third of Israel's water comes from the Jordan. The 1967 conquests are important in this light also because the Golan Heights afford control over the Upper Jordan. According to Stauffer (1983), almost one-half of Israel's total water supply consists of water that has been diverted or preempted from Arab sources located outside of the pre-1967 boundaries.

Data are generally not available for water consumption by Jordan. The history of irrigation in Jordan has been limited and the estimates are that only 4.6 percent of the cultivated land was irrigated in 1972 (compared to 41.1 percent for Israel and 7.6 percent for Syria) Gischler gives figures 7.2 percent and 9.8 percent for Jordan and Syria, respectively. Nevertheless, the population was rising at a rate of 3.4 percent

per year in the early 1970s. Total annual consumption was 555 MCM for 1980 of which 465 MCM were for agriculture, 30 MCM for industrial uses, and 60 MCM for domestic use. The estimates for the year 2000 are for a total annual demand in Jordan for 1009 MCM. There is some concern that Jordan's demand for water will exceed the supply during the 1980s. Others feel that Jordan is facing an ever increasing deficit at the present time which can only lead to a decreased standard of living and/or to curtailed future development. If this is true, then the potential for renewed water-based conflict in the Middle East is imminent. (The Iraqi-Jordanian agreement to divert Euphrates water to northern Jordan is thus of critical importance.)

Overview of Present Status

The Jordan River is extensively developed by both Jordan and Israel. For all practical purposes, the available quantity of high quality water is presently extracted, leaving only poor quality highly saline waters in the main stem of the River Jordan. The potential for conflict here is great because the available water is being used and both societies are expanding with an increasing thirst.

Both Jordan and Israel face severe water deficits. Israel is utilizing 95 percent of its present capacity of 1,700 MCM (including water from the West Bank), and projects that by the year 2000 it will need 2,500 MCM, a deficit of 800 MCM. Jordanian demand is already in excess of its annual supply of 841 MCM (estimated 872 MCM for 1985), and will show a deficit of 168 MCM by the year 2000.

Solutions to these deficits are imperative, and suggestions are varied. These include:

(1) Completion of the Maqarin Dam. This is presently held up by lack of political agreement. This storage facility would salvage about two-thirds of the Yarmuk's annual flow of 492 MCM that is now wasted during the winter floods. Primary advantage would go to Jordan, to which the major share of Yarmuk waters was allocated and which already has the East Ghor Canal to utilize them.

(2) Conservation in agriculture. Jordan, whose modern agricultural facilities were installed in the 1970s, is already heavily invested in water-saving drip irrigation. Israel's installations, installed earlier, are over 90 percent sprinkler irrigated, which uses more water. Jordan has found that drip irrigation and plasticulture pay large dividends in crop profitability, but immediate conversion for Israel would be costly.

(3) Advanced technologies. Israel has been experimenting with cloud seeding, catchment, ground-water recharge, waste purification, and desalination. Costs are high -- perhaps beyond economic feasibility levels -- and yields are small.

(4) De-emphasis on agriculture. In technical terms, this would be more feasible for Israel than for Jordan. Jordan lacks the industrial infrastructure to provide alternative employment; moreover, its agriculture is relatively unsubsidized, uses advanced technology, and shows a profit in response to free-market forces. Israeli agriculture is heavily subsidized, both in terms of the price of irrigation water and in direct subsidies to farmers; but agriculture in Israel is bound up in Zionist ideology and is protected by powerful lobbies that cut across political party lines. Although Israel does have substantial industrial

infrastructure, its present economic plight makes investment for the conversion to industry improbable even if it were ideologically palatable.

(5) Buying water from neighboring systems. Israel has talked about buying water from the Litani and — since the time of Sadat — from the Nile. Jordan has considered piping water from the lower Euphrates. In view of the present and projected in-basin needs of these systems, such schemes offer little joy for thirsty Jordan and Israel.

(6) The Med-Dead Canal. A canal from the Mediterranean Sea to the Great Rift Valley (alternatively from the Red Sea to the Valley) has been discussed off and on for forty years. It would provide generous amounts of hydroelectric power, but it would cause severe problems for existing mining operations in both Israel and Jordan and offers no solution to the urgent need for fresh water.

THE LITANI

HYDROLOGY OF THE LITANI

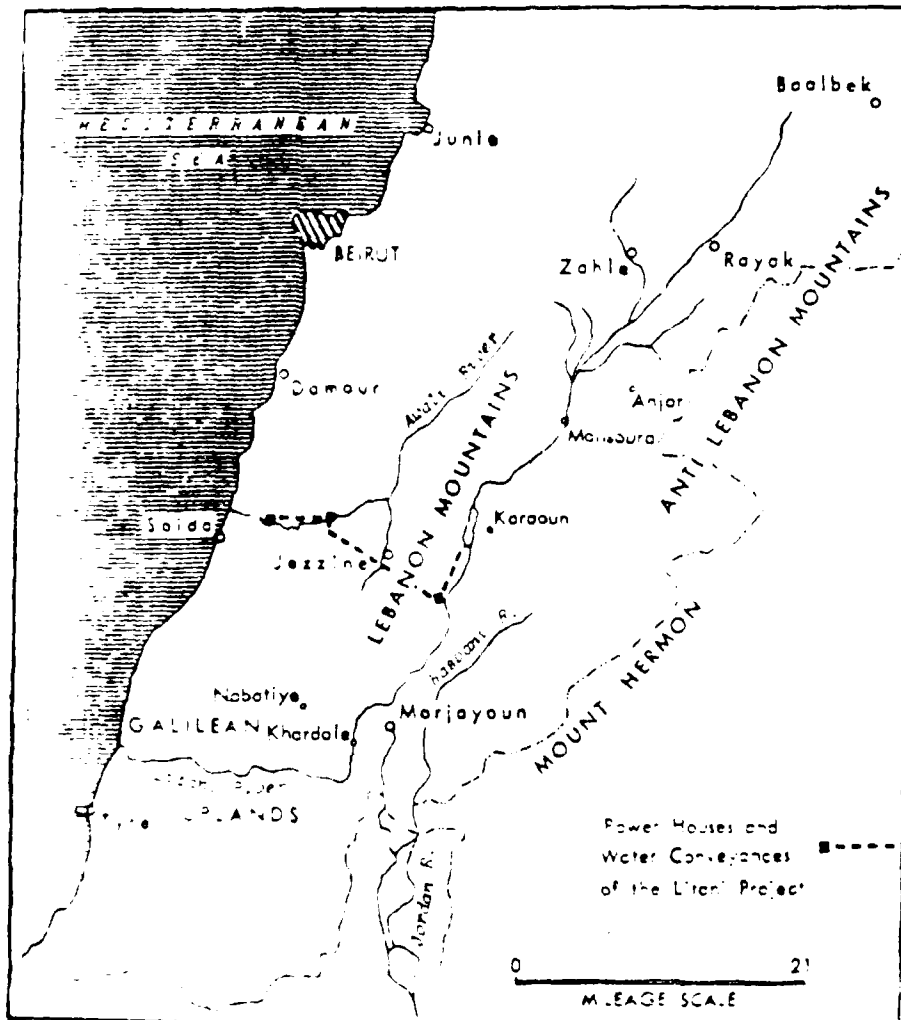
The Litani River lies entirely within the internationally recognized boundaries of Lebanon. It rises in the Bekaa Valley, a short distance west of Baalbek (only a few km southwest of the headwaters of the Orontes), and flows south down the axis of the Bekaa Valley between the Lebanon Mountains on the West and the Anti-Lebanon Mountains on the East. The two mountain systems are underlain by deformed Mesozoic carbonate rocks; the Bekaa Valley itself is developed in a fault-bounded depression filled with younger sediments. The discharge of the stream is derived from winter rainfall over the higher portions of the flanking mountain ranges, supplemented by groundwater contributions to base flow carried to the late-Cenozoic alluvial fill on the floor of the Bekaa Valley from the slopes of the mountains. At Qirawn the Litani enters a gorge between the Lebanon Mountains and the massif of Mount Hermon; near Nabatiya the river turns sharply to the west and flows to the Mediterranean through the Galilean Uplands, a hilly terrain underlain by Mesozoic and early Cenozoic carbonate rocks.

More rain falls over the Litani than over other rivers in the region. The higher slopes of the Lebanon Mountains receive on the order of 1000-1600 mm/yr. In the rain shadow east of that range the precipitation is as low as 500 mm/yr. The lower part of the Litani Basin receives winter rainfall directly off the Mediterranean, typically amounting to the order of 800 mm/yr.

The flow of the Litani averages approximately 700 MCM, of which only 60 is contributed below Nabatiya. In the dry months of July to October,

the flow is only 15 percent of the total. There are great variations from year to year.

A glance at the map of Figure 5 will show how closely the Litani approaches the headwaters of the Jordan. Several ideological treatments of water resources in the region have referred to the Litani and the Jordan as a single river system; the Israelis make that argument whenever they contemplate diversion of the upper Litani into the Hasbani. At least one commentator on Middle Eastern politics has correlated the current Israeli presence in southern Lebanon with Israel's realization that it has utilized all the water now available to it within its post-1967 borders.



HISTORY OF THE LITANI

The area of the Litani basin is sparsely populated and relies on subsistence agriculture. The land tenure system consists mostly of small freeholders, whose terrace farming imposed little burden on the water resources of the river. The difficult hydrological structure of the Litani required technology which was not available until modern times.

The Search for Cooperative Solutions: 1948-1955

The French Mandate contributed little to agricultural development in the south of Lebanon. The Lebanese Republic, which was granted independence in 1943, planned some small irrigation projects. One of them was the Qasimiyah Plan to irrigate 3,900 hectares of land in the coastal plain between Tyre and Sidon. The 1943 Bekaa Valley survey envisioned the utilization of the Litani for hydroelectrical power and irrigation. None of the plans were implemented until after the 1948 Arab-Israeli war.

The Litani assumed great importance after the war. Concerns were voiced in 1949 that the country's 1.2 million population would double in two decades from natural increase, not counting the influx of 127,000 Palestinian refugees. Lebanon was less dominated by agriculture than most Middle Eastern states. In 1950, less than 20 percent of the GNP was contributed by agriculture, and less than half the land was deemed suitable for cultivation. Of the cultivated land, 80 percent was rainfed. Irrigation and crop diversification were needed to increase output and diminish variation in productivity due to drought.

To solve these problems, the Council of Ministers drew up a Six Year Plan to add 43,000 hectares to irrigated land through development schemes in the Litani, Orontes, Yarmuk, Qasimiyah, and Akkar. In addition, the Plan sought to utilize the rivers to generate hydroelectric power. The water schemes were elaborated by the Planning Board set up in 1953, and the Ministry of General Planning which was created in 1954.

The most important part of the Six Year Plan was the Litani River project. It was based on surveys carried out by the United States Bureau of Reclamation in the early 1950s. The multi-purpose Litani scheme, scheduled to take 20-25 years for completion, was expected to increase the electric output of the country from 181 million kwh in 1954 to 807 million kwh, to irrigate 250,000 dunam (25,000 hectares) of land, and to provide employment for 300,000 people. The Litani River Authority was created in 1954 to supervise the implementation of the program.

A key element in the Litani River Project was the dam on Lake Qirawn. In addition the plan included: 1) six hydroelectric power stations, 2) three big and five small dams 3) 41 kilometers of tunnel and 4) 210 kilometers of irrigation channels. The first section of the project included construction of the dam at Lake Qirawn and the two hydroelectrical storage systems, one on the Litani and one on the Awali. The first irrigation schemes were planned for the Bekaa Valley, in the Sidon-Beirut area, and in small parts of the Galilean Upland.

The Litani River Project took no account of concurrent Israeli proposals to divert the Litani out of Lebanon into the Jordan. The World Zionist Organization had in 1919 demanded that the East-West section of the river become the international border to Palestine. The Lowdermilk plan of 1944 and the Hayes plan of 1948 both treated the Litani as part of the Jordan River System, and based their regional cooperation on the

utilization of half of the Litani flow for the benefit of Israel. The most elaborate presentation was made in the Cotton plan, which estimated the Litani surplus water potential to be approximately 500 MCM. It was to be used through a 100-kilometer diversion scheme based on channels, tunnels, and aqueducts to provide irrigation and electric power in Northern Israel.

In rebuttal, the Arab countries pointed out that Israel underestimated the extent of Lebanon's use of the Litani waters. Both the U.S. Bureau of Reclamation in its 1954 Report and Lebanon's Litani River Project assumed that 80 percent of the Litani water would be used in Lebanon. Moreover, selling the Litani water away from an area where Shiite farmers did not receive enough for irrigation would have fomented resentment against the Christian dominated government in Beirut. However, as with the Jordan River System, the dominant argument used was based on considerations of Arab politics. Lebanon, though nonbelligerent, could not risk a bilateral agreement with Israel without the consent of the other Arab states. Yet such a consent was highly unlikely because of the continued Arab-Israeli conflict. According to Israeli estimates, Lebanon, in rejecting the Litani-Jordan scheme, passed up an opportunity to optimize the use of the water. Israel argued that the differences in altitude between the Litani area and Israel could be used to generate cheaper electricity than in the Litani River Project.

Problems of Implementation: 1955-1970

Work on the first section of the Litani River Project was started in 1956. It included the Qirawn Dam and two hydroelectric power stations.

one on the Litani River and one on the Awali River. In line with the recommendation of the US Bureau of Reclamation, hydroelectrical uses of the waters was preferred over irrigation. This policy was part of a general economic outlook which emphasized urban and industrial development in Lebanon. The Bureau of Reclamation predicted that the need for electricity would increase by 11 percent until 1965 and then level off at 6 percent. In the first phase of the plan 336 million kwh were expected to be generated.

The much more modest irrigation targets were revised a number of times. The coastal units proposed in the original plan were dropped, but the areas for irrigation in the southern Bekaa were to be enlarged and allotted 100 MCM to be withdrawn from the Qirawn Reservoir.

Major technical problems policy plagued the project. Projections of possible earthquake damage necessitated dismantling of a partially completed section of the cement dam and its replacement by a rock-filled structure. Cave-ins and flooding blocked a major tunnel. The Awali-Markaba section was changed to enlarge its intake.

Electricity and domestic use received increasing preference over irrigation. The growth of the urban centers and the life style of the middle class Christians and Sunnis, which mandated the use of electric appliances and air conditioning overturned the projection that the rate of growth in electrical consumption would taper off. The use of electricity increased dramatically from 80 million kwh in 1948 to 900 million kwh in 1964. By 1967, the actual consumption rate was 30 percent higher than predicted. It also changed the pattern of peak demand. In 1951, the peak demand for electricity in Lebanon was in December; in 1964, primarily because of the use of air conditioning, it was in August.

As a result more water than planned had to be diverted for electricity at the time of low river flows.

The tensions between these diverging needs was exemplified in the dispute between the "600 m" and the "800 m" plans. The former would divert 105 MCM of water after it was used for power generation at Markaba through a transmountain tunnel at 600 meters elevation to deliver water to irrigate 5,000 hectares around Sidon and 2,500 hectares around Nabatiya. The rival "800 m" plan envisaged diversion of the same amount of water from Lake Qirawn (at elevation 800 m). Such a diversion would have precluded the use of the 105 MCM for generating hydroelectric power. The allocation of irrigated land would then be: 8000 hectares in the southern part of the lower Litani, 3,000 hectares around Nabatiyeh, 2,500 east of Sidon and the remaining 1,500 hectares near Marjayoun.

The dispute reveals the preponderancy of sectarian considerations in Lebanon. According to the latest demographic survey conducted by the French Family Planning Institute in 1977, the population of Lebanon was 3.11 million, distributed as follows: 750,000 Maronite Catholics, 300,000 Greek Orthodox, 200,000 Greek Catholics, 600,000 Sunni Muslim, 850,000 Shiite Muslims and 250,000 Druzes, and 160,000 Armenians. Most of the Shiite Muslims, considered the poorest group in the society, lived in the south and had no share in the political division of power. The Christian-dominated government of Lebanon did not view the development of their region a major priority. The "800 m" plan beneficial to the Shiite community was adopted, but was implemented with pilot projects near Sidon not inconsistent with the rival plan.

Use of the Litani for hydroelectricity rather than irrigation was more profitable in terms of a quick return on investment, development of industry, and the outright sale of electric power to Syria. Domestic use

was stimulated by the quick growth of urban centers, where Christians predominated.

The Activation of the Litani Issue: 1970-1983

Already in the early 1970s, there was a growing process of disintegration in the south of Lebanon. Demographically, the Shiites had become a majority of the roughly 600,000 inhabitants of the south. The failure of the central government to rehabilitate the area increased the tension between the Shiites and their Christian and Sunni neighbors and with the Druze further up the Shouf Mountain. Most of the country's cultivated area were controlled by the Maronites and the Druze.

The failure to irrigate the south had been a continuous source of frustration among the Shiites of the region. Their resentment toward the Christian dominated government was increased by two related developments. In 1972, the Lebanese government signed an agreement to supply 100 million kwh of electricity to southern Syria. A drought in summer, 1973 lowered the water table in the Litani and Lake Qirawn; electricity output was cut by some 40 percent, causing shortages of water and electricity locally. On August 16, 1973, the Director General of the Lebanese Electricity Company asked the public to reduce use of electricity. The water and electricity shortages in the south caused major demonstrations in the region. Shiite apprehension was increased in 1974 when it was rumored the Litani River would be diverted to Beirut to meet water shortages in the capital. The neglect of the agriculture of the south and the diversion rumors apparently contributed to the subsequent decision of the Shiites to form the paramilitary Amal movement.

Discontent in southern Lebanon was fed by the growth of PLO strength in the area. Following their 1971 expulsion from Jordan, the PLO established a territorial base in the neglected and sparsely populated south of Lebanon. The PLO move was facilitated by tacit ties with dissatisfied Shiites in the south and cooperation between the PLO and Amal militia in Beirut.

Chaos in the south of Lebanon affected development plans for the region setting up a vicious circle of administrative and planning isolation which enhanced dissatisfaction. One measure of isolation is the virtual disappearance of statistical data on the south from official Lebanese publications. As a result, it is difficult to evaluate progress on the Litani River Project since the early 1970s.

From the Arab Report and Record, spotty information indicates that financing for some small projects was solicited from a number of sources. In 1966, the Kuwaitis promised 65 million Lebanese pounds to build the Muifadoun Dam on the Litani near Nabatiya to store water for irrigation. In April, 1972, the Lebanese Minister of Hydro-electric Resources asked a delegation from the World Bank to finance a Litani scheme to irrigate 23,000 hectares of land in the southern Bekaa Valley and provide a new water network for Beirut. In October 1974, the President of the Council of the Administration of the National Office of the Litani and its Director General signed an agreement in principle for the World Bank to provide 60% of the \$130 million cost of the ten-year project. In September 1978 the Director General of UNICEF promised to finance a pumping system to provide 90 million liters of water for domestic consumption.

The growing disintegration in the South has made it difficult to assess whether Litani projects have been implemented. It is also difficult to assess war-related damages to the existing installations. In

recent years. Lebanese budget and financial reports often list damage repair costs together with maintenance.

Israeli incursions into Lebanon since the early 1970s internationalized the Litani River question. Israeli interventions throughout the 70s led up to Operation Litani in 1978 and the 1982 war; the IDF (Israel Defence Force) has maintained a line on the Awali River since September 1983.

Given the historical interest of Israel in the Litani River, these actions raised speculation that they may have been motivated by water interests. One early allegation claimed that Israel, through the intervention of the United States, blocked financing of an early 1970s plan for a second dam on the Litani to irrigate the lower Bekaa Valley.

An Arab press item on January 12, 1978 in al-Siyaasa reported that about 32 percent of the land in southern Lebanon had been sold indirectly to Israelis; a subsequent Lebanese intelligence investigation allegedly found that Lebanese Phalangists and members of the National Liberal Party were buying land from poor peasants and reselling it to Europeans. Lebanese and U.N. sources maintained that, following the 1978 invasion Israel had consolidated control of the Wazzani-Hasbani springs to increase water flow to the Jordan River; rumors of Israeli-imposed conservation measures were denied in 1983 by Major Saad Haddad.

After the 1982 war, Israel gained control of the lower Litani. According to the Chairman of Lebanon's Litani River Authority, the IDF seized a complete set of hydrographic and seismic data on the system.

In an exclusive interview in the Lebanese periodical Monday Morning of December 26, 1982, Yevgeni M. Primakov, the Director of the Soviet Government Institute of Oriental Studies, charged that Israel had

already started diversion of the Litani. The Soviet official argued that Israel's demand for a 45-km security zone in Lebanon was an attempt to annex south Lebanon up to the Litani. Similar claims have been published in English, French, and Arabic articles which appeared during and after the invasion. Even without substantiation, such rumors and reports have fed the traditional fears of Shiites in the south and created the perception that Israeli moves are motivated by water needs.

The interest of the Israeli Government in the Litani in the 1950s was apparently conditional on whether a diversion could be secured through legal means. The recently published diaries of David Ben-Gurion and Moshe Sharett indicate that Ben Gurion overruled a plan by Moshe Dayan to annex southern Lebanon.

It is impossible to know whether Litani diversion was seriously discussed by the Likud government in 1981. Both the Defense Minister Ariel Sharon and the Minister of Science and Technology Yuval Ne'eman have occasionally spoken in favor of such a project. However, published records of the decision-making process of the Cabinet including the investigation of the Kahane Commission on the Beirut Massacre indicate that the decision to invade in June 1982 was dominated by two considerations: (1) to destroy the territorial base of the PLO in Lebanon; (2) to create a strong Maronite government in Lebanon.

The feasibility of Litani diversion depends on the amount of available Litani flow. Traditionally, Israeli sources have estimated that slightly less than 50 percent, i.e., some 300 MCM of Litani waters are not utilized. Lebanese sources have claimed that up to 80 percent of the flow is utilized, thus leaving only 100 MCM free. Events between 1972 and 1983, involving massive population movement in and out of the region, have greatly disrupted the pattern of water usage for both irri-

gation and hydroelectricity. But according to a recent statement by Yuval Ne'eman, the amount of water left in the Litani does not justify diversion. Ne'eman cited no figures, but (on the authority of Ariel Sharon) described the amount as a "trickle".

Israel did not raise the issue in its May 1983 negotiations with the government of Amin Gemayel. In view of Lebanon's own needs - not to mention its political problems - any sale or transfer of water to Israel appears problematic. Two plans for such transfer have been discussed by the Israelis. One involves diverting the Litani into the Hasbani at the point of closest proximity. The other involves a 250-km long canal or pipeline along the coastal plain from the lower Litani. The estimated cost of water through such an arrangement is high - about 10 cents per cubic meter. The installation would also be vulnerable to politically motivated sabotage, and would probably require a permanent Israeli control over southern Lebanon. The direct cost of the present Israeli occupation of that area has been estimated at \$1 million per day. Israel's other options to meet its impending water deficit would appear less costly than the coercive diversion of the Litani.

TECHNOLOGICAL ASPECTS OF THE LITANI RIVER

Water Quality

As is true with the other river systems of the Middle East, few data are available regarding water quality. The primary concern is with salinity because of its role in determining the suitability of water for irrigation purposes. The Litani River is a high quality water averaging about 20 ppm salinity which renders this water usable for irrigation of any crop.

The future of water quality in the Litani will largely be a function of development in the basin. The most likely source degrading water quality will be irrigation return water. This assumes an increase in the agriculture development of the Upper (and Lower) Litani River which in turn necessitates a period of stability in the Basin. However, given current conditions, the continued high quality of the Litani seems assured for some time to come. Of course, it is this purity which makes the Litani very attractive to the Israelis who have developed their National Water Carrier System with a view towards potable (as opposed to irrigation quality) water.

Water Development Plans for the Litani

The general rule regarding planning in the Middle East is that detailed planning documents are not available. The continued strife and the preoccupation that goes with it have precluded the preparation of

projections of population, industrial and agricultural growth. As a consequence, assessments of future water requirements are risky and can only be made in reference to the plans of the past.

Development of water resources in Lebanon was slow until the post-World War II period. During the French Mandate, development was limited to two local irrigation projects: at 'Anjar in the Bekaa and Qasimiyah on the coast. In the late 1940s and early 1950s, a number of plans were developed, the most detailed and elaborate of which was prepared by the U.S. Bureau of Reclamation. The basis of the Reclamation Plan was that it makes more economic sense to use water to generate hydroelectricity than it does to irrigate crops. Consequently, the Bureau of Reclamation Plan emphasized the production of electricity. This is seen in terms of annual costs, 50 percent of which were associated with thermal electricity, 40 percent with hydroelectricity, and 5 percent with irrigation. On the other hand, in terms of water, 10 percent of the annual water was allocated to exclusive use in irrigation and 25 percent for power followed by irrigation. The plan as envisioned included a storage dam at the southern end of the Bekaa near Qirawn, and two hydroelectricity systems. The first of these would discharge its tailwaters to the Litani below the dam. The other hydrosystem included a substantial diversion of the waters of the Litani to the Awali River. The plan also included some suggestions for irrigation in part of the southern Bekaa, in scattered areas of good land in the Galilean Uplands and parts of the Sidon-Beirut coastal area.

The project itself was initiated in the late 1950s, and most of the features of the original plan were realized. The completed project included the Qirawn Reservoir and the Awali power system, with irrigation and the Lower Litani power system remaining as future goals. The fruit-

tion of the Litani Project brought about a significant redistribution of the waters of Lebanon.

Redistribution of Water

With the new hydroelectric system activated, the water resources of the Litani were dramatically re-allocated geographically. At Markaba, the location of the tunnel through which water of the Litani is diverted to the Awali, the seasonal variability has been damped. At Markaba, the total annual flow of 520 MCM includes 390 MCM transported by the power drop from the dam and 130 MCM provided by inflow to the river below the dam. From Markaba, 25 MCM per year is sent down the Litani to meet the peak dry weather demands of the Qasimiyah Project. The remainder goes through the tunnel to the Awali, making the Awali the largest river (645 MCM per year) in Lebanon. Thus, on the Litani below Markaba, we have 25 MCM for Qasimiyah plus 120 MCM of inflow between Markaba and Khardali for a total of 145 MCM per year at Khardali (versus 640 MCM at Khardali before completion of the Litani Project)> Inflow from the arid region below Khardali of 60 MCM provides 205 MCM to the Lower Litani. Of this, over 80 MCM are committed to Qasimiyah, leaving 125 MCM in the Lower Basin with essentially no water available in the five to six month summer period.

The pattern of development of water resources in Lebanon has thus taken the direction of the generation of electricity as the first objective. Hydropower has been especially economical for Lebanon because thermal electricity is seen to be 15 to 20 percent more costly in addition to which the steam electric power plants in Lebanon rely on oil. In recent times, agriculture has accounted for about 12 percent of the gross

domestic product of Lebanon. Development of irrigation systems in Lebanon, and especially in the Litani Basin, has been delayed because the hydroelectric facilities have been more profitable. Irrigation-based agriculture has been expanded in the southern Bekaa. This area was allocated 100 MCM annually to be pumped from the reservoir. Internal Lebanese politics has played a role in impeding the development of irrigation in the Galilean Uplands.

Although the development of the Litani was undertaken to provide hydropower, it is clear that agricultural, population and industrial growth demands following the return of stability to Lebanon will place a heavy drain on the waters of the Litani-Awali. However, it is reasonable to assume that it will be some time before the Lebanese demand will reach such levels. Competing demands for this water will provide an additional source of friction in the region because it is relatively easy to divert the waters of the Litani to other drainage basins, i.e., the Awali and the Jordan.

The Litani lies entirely within the national borders of Lebanon. Nevertheless, there have been numerous discussions regarding possible diversions involving the Litani. As noted above, large quantities of this water are already diverted to the Awali. In the early 1960s, the Arab states proposed to divert a portion of the Jordan headwaters to the Litani. The most persistent plans have involved Israel. After World War I, the Zionists wished to have the Palestine Mandate extended to or beyond the Lower Litani. In the 1950s, the Israelis proposed that Litani water be diverted to the Upper Jordan, used to generate hydroelectricity and eventually be added to Lake Tiberias, reducing its salinity and thus being available for further use. The traditional Israeli position has

been that the Litani is part of the Jordan River System. The Lowdermilk Plan of 1944 and the Hays-Savage Plan of 1948 considered the Litani to be part of the Jordan River System. Both plans based their regional cooperation on the utilization of approximately half the flow of the Litani to augment the Jordan and to generate hydroelectric power in Lebanon and Israel.

Current intentions of Israel vis-a-vis the Litani are unclear. However, given recent history, it is not unreasonable to assume, at the very least, an extreme interest in developing this resource. In order to avail itself of the complete quantity of Litani water, it would be necessary for Israel to control a substantial portion of the Bekaa Valley because of the upstream Lebanese facilities. That is, control of the Lower Litani would yield on the order of 100 MCM per annum, whereas control of the Upper River Valley would make available up to five or six times as much. Stauffer indicates that Israel would have to capture the entire Bekaa Valley south of the Damascus-Beirut road in order to get all the water, preempt the existing Lebanese use of the river, control the dam at Qirawn in order to facilitate downstream extraction, and protect the diversion system from counterattack.

Water Usage

Consumption of water in the Litani follows the pattern of social organization in the basin: most people in the basin are villagers and traditional agriculture is the major occupation. Precipitation is highly seasonal and varies substantially from year to year. Flow is somewhat less seasonal because of snow storage and groundwater storage. Nevertheless, the flow regime of the Litani follows a definite seasonal trend.

Most (60-65 percent) of the annual flow occurs during a four month period (January through April); 15 percent occurs during May and June; 12 percent during June through October; and, 10 percent during November and December. Hence, significant water resource development requires the use of reservoirs to provide the storage necessary to damp the cyclical fluctuations in water availability. This is true of all the drainage basins of the region.

The five major uses of the Litani water are households and businesses, industries, hydroelectric power, cooling water for steam electric power plants, and irrigation. The first four are primarily urban uses and largely non-consumptive (less than 20 percent or so) in nature. Hence, they provide the greatest opportunity for re-use. Irrigation is highly consumptive; data from other agricultural settings indicate that 40-50 percent is used for plant transpiration, and most of the remainder is lost through evaporation or seepage. The significance of this for Lebanon has been that any water used for irrigation in the Bekaa is not available for power generation downstream. In the Lebanese setting, the use of water for irrigation is a low productive use of water, and much more extensive use has been made for the generation of electricity. Approximately 21.5 percent of the cultivated land in Lebanon was under irrigation in 1972. According to Gischler, the figure later dropped to 16.4 percent.

OVERVIEW OF PRESENT STATUS

On the surface, the Litani River is not troublesome. There is only one riparian user, and, at the present time, there is sufficient flow in the river to satisfy the needs of that user. However, the future will probably not be quiescent. In the first place, the Litani River represents the only additional surface supply of high quality water within reach to slake Israel's expanding demand. Secondly, when peace does come to Lebanon, and developmental pressures resume, there will be an increasing internal demand placed on the reserves of the Litani River.

Water shortages are common in Beirut; in the dry season from August to December there is country-wide rationing of domestic water. Future domestic consumption depends on developing 1,100 springs and 372 wells, some of which have become saline because of overpumping. A project to divert water from the Awali to Beirut was planned but not implemented because of the war. The World Bank Reconstruction Report of 1983 recommended a National Water Master Plan. One of its projects, the Beirut Awali Water Carrier, would draw from the Litani water resources.

Population increase among the rural Shiites puts increasing demand on water for irrigation. Agricultural statistics from a 1973 report list 720,000 hectares of irrigated land, with irrigation available to 45 percent of the farms. Some 75 percent of the water was supplied by open ditches, and five percent by pumps.

According to the World Bank, the country has a relative abundance of water resources, but may face critical shortages in the near future for both domestic and agricultural usage.

THE EUPHRATES RIVER AND THE SHATT AL-ARAB

HYDROLOGY OF THE EUPHRATES AND SHATT AL-ARAB RIVER SYSTEMS

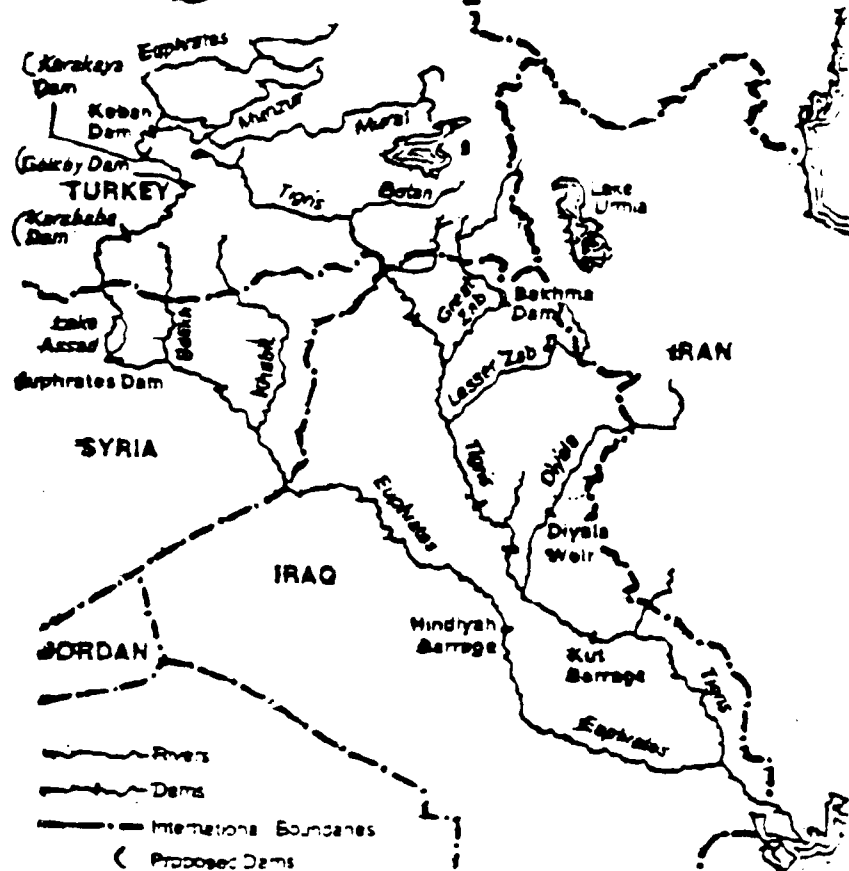
Introduction

Both the Euphrates and the Tigris rise in the mountains of southeastern Turkey and flow across the progressively drier central lowlands of Syria and Iraq to join to form the Shatt al-Arab at Basra, just above the head of the Persian Gulf. The Tigris receives flow from a series of rivers that drain the western slopes of the Taurus-Zagros; one of these, the Kharun, enters the Shatt al-Arab below the junction of the Tigris.

One cannot consider the Shatt al-Arab without taking into account the contributions of its major tributaries; thus, we will deal here with the integrated system of the Euphrates-Tigris-Shatt al-Arab-Kharun (see map of Figure ---).

Euphrates River: The Euphrates rises from winter rainfall over the high mountains of southeastern Turkey, where annual precipitation may exceed 1,000 mm/yr and tortuous tributary streams find their way through and among the site of the Keban Dam. Below the dam the Euphrates flows down the steep slopes at the southern margin of the mountains of the Kurdistan and Armenian areas, and enters the region of the eastern plains of Syria, underlain by largely underformed sedimentary rocks of Tertiary age, where annual rainfall is less than 200 mm. In this stretch the Euphrates is joined by two major tributaries, the Balikh and the Khabur, both of which also rise from the southern slopes of the mountains in southeastern Turkey. The Euphrates and its tributaries drain an enormous basin 444,000 sq km in area, of which 28 percent lies in Turkey 17

The Tigris and Euphrates

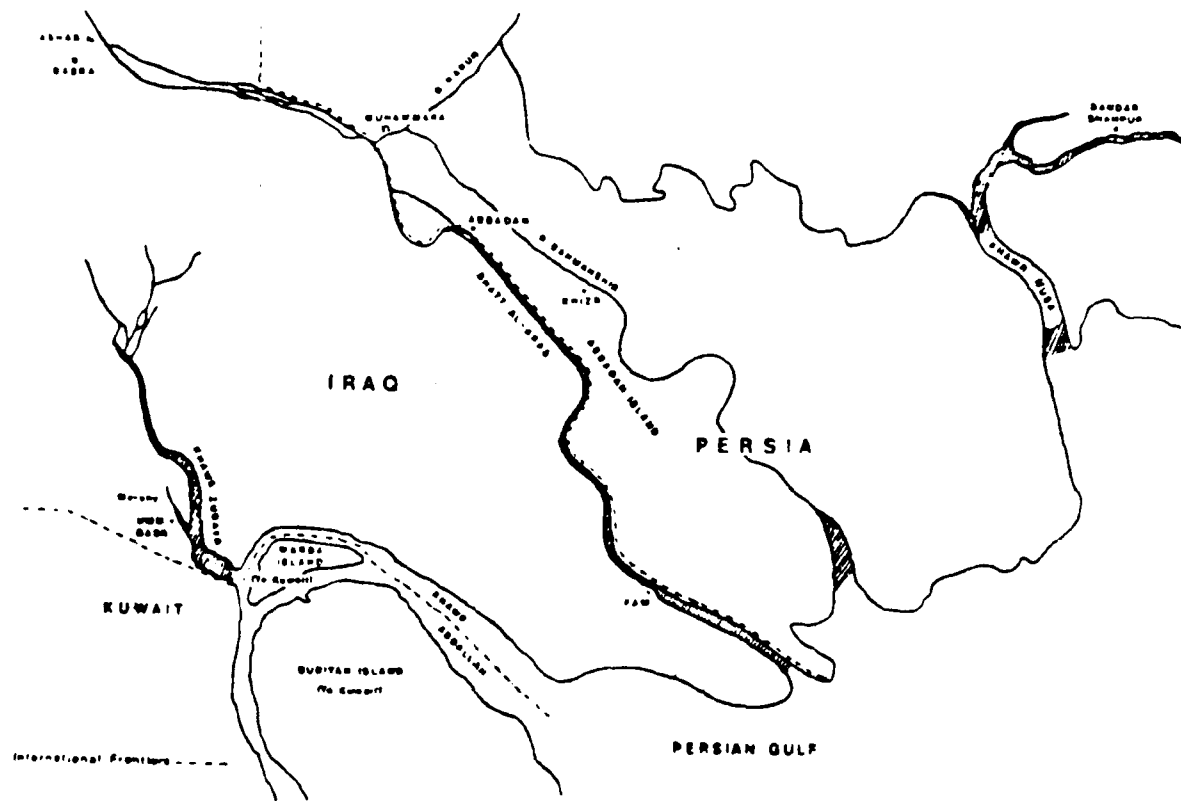


percent in Syria, 40 percent in Iraq and 15 percent in Saudi Arabia. Approximately 88 percent of the mean annual flow is generated within Turkey and almost all of the remaining 12 percent within Syria. Except in years of exceptional rainfall Iraq's contribution to the waters of the Euphrates is virtually zero.

One hundred kilometers downstream from its confluence with the Khabur, the Euphrates enters Iraq, where it receives no further discharge from any source (despite the well-developed erosional network of perennially dry wadis that enter the lower Euphrates from the southwest in Iraq). The Euphrates is joined by the Tigris just above Basra, only 100 km from the head of the Persian Gulf, to form the Shatt al-Arab. The courses of the two principal tributaries are difficult to trace across the very low-relief terrain that represents recent alluvial fill in the head of the Persian Gulf. There is a well documented history of significant change in the configurations of the stream channels, as the upper end of the Gulf has been filled during the last 5,000 years.

Tigris River: The Tigris also rises in the mountains of southeast Turkey, but much of the potential drainage basin of the upper Tigris is cut off by the trellis development of the upper Euphrates. The Tigris compensates for this loss by receiving the substantial discharge from the Greater Zab, the Lesser Zab, the Adhaim, the Diyala, and many smaller streams that drain the west slopes of the Taurus-Zagros Mountain system; those farthest to the southeast are cut off by development of the upper Kharun, which enters the Shatt al-Arab below the confluence of the Tigris and Euphrates.

Shatt al-Arab: The Shatt al-Arab is the name assigned to the lowest reach of the system, below the confluence of the Tigris and Euphrates



The Iraqi-Persian Frontier

above Basra. The exact location of that confluence is not clear; much of the discharge from the two rivers mingles in a system of swamplands that extend from Qurna to Basra, and the most apparent point of confluence has changed through time. The combined area of the lakes and swamps at the head of the Persian Gulf varies from 8,288 sq km at the end of the dry season to 28,490 sq km during the spring flood, fed by winter rains and snowmelt in the mountains of Turkey. During the 1946 flood the total inundated area reached 90,650 sq km. The Shatt al-Arab lies within Iraq until a point about 60 km above the Gulf (15 km above the entry of the Kharun), from which point the Shatt al-Arab represents the international boundary between Iran and Iraq and a theater of intense military action for the last three and a half years.

Kharun River: The Kharun is the longest river in Iran, measuring about 800 km in length and draining an area of 67,340 sq km. The river rises high in the Zagros, and carries a large volume of water and suspended sediment into the Shatt al-Arab some 35 km below Basra.

Discharge

Euphrates River: The Euphrates River carries an average of 31,820 MCM/yr (26,400 according to Cressey). The annual discharge varies from 16,871 MCM to 43,457 MCM; minimum instantaneous discharge according to Cressey has been 181 m³/sec (equivalent to 5,700 MCM/yr), while maximum instantaneous discharge has been 5,200 m³/sec (equivalent to 164,000 MCM/yr). The melting of winter snows in the uplands of Turkey releases large quantities of water into the river to produce a very marked discharge peak during April and May, when the discharge at Hit, Iraq

averages $2,400 \text{ m}^3/\text{sec}$. The discharge drops sharply in June and July as the frozen precipitation of the winter season is exhausted and the nearly rainless summer begins. In August, September and October the mean discharge at Hit is around $300 \text{ m}^3/\text{sec}$. In a year of heavy winter precipitation, however, the peak discharge in May can reach $4,300 \text{ m}^3/\text{sec}$, while there is little increase in the average summer flow level. After a dry winter the discharge in April or May can be as low as $1,300 \text{ m}^3/\text{sec}$ and may drop to about $100 \text{ m}^3/\text{sec}$ in August and September. Thus in one year as much as twice the average amount of water may flow in the Euphrates, while in another little more than half the average annual discharge may be generated. The discharge of the Euphrates diminishes systematically with distance downstream after its confluence with the Khabur, primarily as a result of evaporation and infiltration into the subsurface; within the region of swampland in the upper delta, both before and after confluence with the Tigris, the influence of large-scale transpiration by aquatic vegetation further diminishes flow. The Euphrates has carried as much as 6,100 ppm silt by weight; most of this is deposited in the inland delta and does not reach the Persian Gulf.

Tigris River: The Tigris acquires most of its discharge from Turkey and Iran; contributions to its discharge from within Iraq are limited to the flow of the streams that enter the middle stretch of the Tigris from the western slopes of the Zagros.

The Tigris carries a mean annual discharge of $1,339 \text{ m}^3/\text{sec}$, equivalent to 42,230 MCM/yr. Minimum instantaneous discharge has been $163 \text{ m}^3/\text{sec}$, equivalent to 5,140 MCM/yr; maximum instantaneous discharge has been $14,000 \text{ m}^3/\text{sec}$, equivalent to 440,000 MCM/yr. The Tigris in its lower reaches is more subject to sudden and destructive flooding than is

the lower Euphrates, since it lies much closer to sources of discharge. Floods in the lower Tigris Valley are particularly destructive when two or more of the "left-bank" tributaries are in flood concurrently. The lower Tigris carries more silt than does the lower Euphrates, also because this stretch of river is closer to the sediment source. At times of flood, the Tigris has carried as much as 20,000 ppm silt by weight, five times the maximum flood load of the Nile (which, like the Euphrates, deposits much of its load of silt far upstream). The Tigris annually moves 40,000,000 meters of sediment past Baghdad, of which only a tenth reaches the Persian Gulf.

Kharun River: The Kharun derives all of its discharge from within Iran. It carries a mean annual flow of 15,500 MCM (according to Beaumont), or 24,150 MCM/yr (according to Cressey). The heavy sediment load that the Kharun carries from the actively rising Zagros chain is dumped directly into the Persian Gulf; this source of sediment has represented a major contribution of the construction of the "inland delta" and the concomitant retreat of the head of the Persian Gulf that has been documented for the last 5,000 years.

HISTORY OF THE EUPHRATES RIVER

"Pre-Critical" Modern Development: 1909-1974

Turkey, Syria and Iraq have all formulated plans and implemented projects beginning in the early decades of this century to achieve flood control on the Euphrates and to use its waters for hydroelectric generation and large-scale irrigation. Planning has been largely on a country by country basis, though there have been technical consultations between the three riparian states since the early 1960's and studies by the World Bank and the Soviet Union have attempted to assess the relative needs of each state. No formal agreement has been reached by the states to govern the allocation of the Euphrates' waters. Throughout the period 1909-1974, however, either the absence of integrated planning for the entire basin nor the failure to reach agreement on water resource sharing led to serious international conflict among the riparian states. Projects implemented in this period did not result in significant adverse ecological consequences in another state and demand for water did not exceed supply.

The farthest downstream riparian is Iraq, whose use of the Euphrates for irrigation dates back 6,000 years and reached a peak under the Abbassids (750-1200 A.D.). Iraq was also the first of the three states to build modern water works on the river. The Hindiya barrage, completed in 1913, made it possible to divert river water into reconstructed irrigation canals dating from ancient and medieval times. In the 1950s a second barrage built at ar-Ramadi allowed Euphrates flood waters to be impounded to Lake Habbaniyah and the Abu Dibil depression, permitting a

measure of flood control. Irrigation projects planned for the area proved unworkable, however, owing to a rapid evaporation rate and a high salt content in the soils of the depression. A new reservoir dam upstream from ar-Ramadi and Hindiya built with Soviet assistance was (scheduled to be) completed at al-Haditha in 1982. The al-Haditha dam is designed to permit more efficient use of the Euphrates by reducing seasonal fluctuations in the river's flow. It may also be intended to bring additional land under irrigation.

Although available data on Iraq's use of the Euphrates for irrigation and other consumptive purposes is very incomplete, it is clear that there has been a steady increase in water usage throughout the 1940s, 50s and 60s. One calculation based on discharge differentials at two recording stations along the river that encompass much of the irrigated land shows that Iraqi water withdrawal has risen from 27.3 percent of mean flow in 1940-49 to 45.1 percent in 1960-69. This represents a 65 percent increase in water extraction in roughly twenty years, much of which has gone to extend agricultural irrigation.

Syria, which lies downstream from Turkey and upstream from Iraq, began to formulate modern plans for harnessing its section of the Euphrates to produce hydroelectricity and irrigate new farm lands in 1957 when Damascus signed an agreement with the Soviet Union to carry out survey and research work on the river. The Soviets submitted their report at the end of 1960, proposing to build a 75-meter-high dam on the Euphrates at Tabqa with an electricity generating capacity of 800,000 kw and the potential to irrigate up to 850,000 hectares of farm land. After an interlude in the early 1960s in which the Syrians sought West German aid to build the Euphrates dam, Syria and the Soviet Union signed an

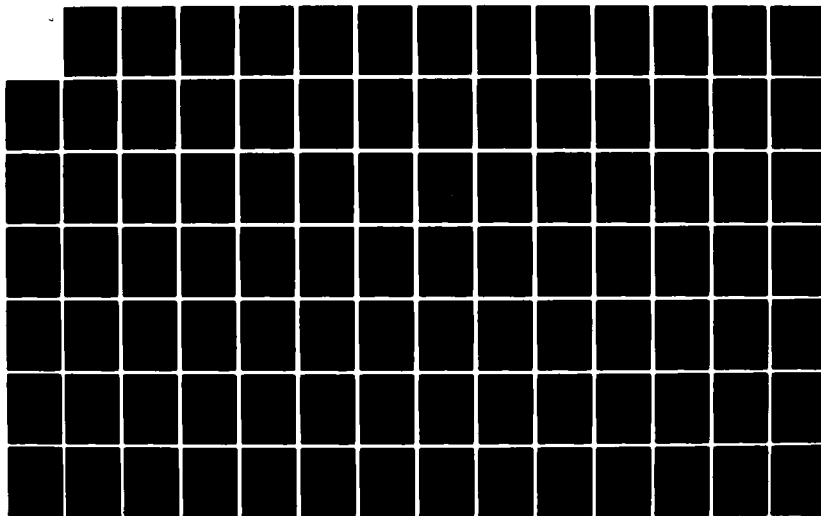
AD-A141 992

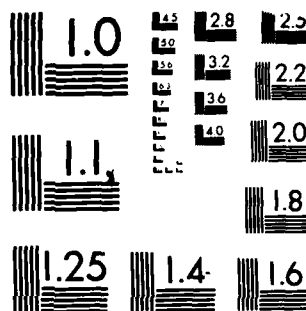
WATER AS A SOURCE OF COOPERATION OR CONFLICT IN THE
MIDDLE EAST(U) PENNSYLVANIA UNIV PHILADELPHIA MIDDLE
EAST RESEARCH INST T NAFF 14 MAY 84 MDA908-83-C-1542
F/G 8/8

23

UNCLASSIFIED

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

accord in April 1966 for Soviet financing and construction of the project. The dam at Tabqa, renamed ath-Thawrah (Revolution) to dramatize the importance the regime placed on the project, was completed in 1973 and began filling during the winter of 1973-74. Up until the completion of the Tabqa dam available estimates suggest that Syria extracted 3,000 MCM per year from the Euphrates for local irrigation and domestic use. Estimates of the amount of irrigated land in the basin prior to the dam's completion vary from 200,000 hectares to 500,000 hectares. In any event the completion of the dam initially resulted in a reduction of the irrigated area as fertile crop lands were inundated by the filling reservoir and new irrigation and land reclamation projects awaited implementation.

Turkey, the upstream riparian, began to develop plans to utilize the Euphrates at about the same time as Syria. Ankara first became interested in the energy potential of the river, which has been estimated at about 45 percent of the country's total hydroelectric power potential. In 1963 feasibility studies for a dam at Keban in central eastern Turkey were completed. Construction began in 1965 and, as in the case of Syria's Tabqa dam, was completed in 1973. The Keban dam is designed to produce hydroelectricity and to reduce drastically the seasonal fluctuation in the Euphrates flow, but it is not intended to supply water for irrigation. Its power plant has an initial installed capacity of 620,000 kw that can be raised to 1,240 kw. The dam is designed to insure a minimum discharge of 450 m³/sec and prevent a maximum discharge of more than 1,000 m³/sec except on rare occasions.

During the 1960s, as their plans for the use of the Euphrates developed, Turkey, Syria and Iraq held a number of discussions concerning the division of the river's waters. Little is known of the content of these discussions since, except on one occasion in 1975, all three countries

seem to have taken pains to keep their talks off the public record. It appears, however, that Turkey linked an agreement with Syria on the Euphrates waters to a Turkish-Syrian accord on the Orontes River. Syria declined this suggestion as the Orontes flows only through Turkey in Alexandretta, a province detached from Syria in 1939 over which Syria still refuses to recognize Turkish sovereignty. During a tripartite meeting in Baghdad in September 1965, Iraq is said to have demanded 18,000 MCM of Euphrates water per year, Syria 13,000 MCM per year and Turkey 14,000 MCM per year. This is a total of 45,000 MCM per year, or 1.4 times the Euphrates mean annual discharge of 32,000 MCM at Hit. Iraq. In early 1967 Iraq and Syria were still reported to be far apart on the question of water allocation, with Iraq demanding 16,000 MCM per year from Syria and Syria insisting that Iraq needed no more than 9,000 MCM per year.

A World Bank report in 1965 and a Soviet study in 1972 based in part on the World Bank's data have attempted to assess the relative needs of the three riparian states. The states have released partial information said to be derived from the reports, but these studies themselves have not been made public.

The only formal agreement extent relevant to the Euphrates waters is the March 29, 1946 Iraq-Turkey friendship treaty which obligates Turkey to inform Iraq of plans for conservation works on the Tigris and Euphrates and to adapt projects "as far as possible" to the interests of both states. The three riparian states had not reached any further formal agreement by the time the Keban and Tabqa dams began to fill in the winter of 1973-74.

THE SYRIAN-IRAQI "WATER CRISIS" OF 1974-75

The first year that the Keban and Tabqa dams began to fill passed without serious incident. Although Iraq experienced a sharp reduction in the discharge reaching its territory and in mid-74 requested that Syria release an additional 200 MCM of water from Tabqa, Syria acceded to Baghdad's request and no conflict arose.

During the second season that the Turkish and Syrian dams impounded part of the Euphrates' spring flood, however, a major crisis developed between Syria and Iraq that brought the two countries to the brink of war. On April 7, 1975 Iraq issued an urgent request for a meeting of the Arab League Foreign Ministers to discuss its claim that Syria had reduced the river's flow to an intolerably low level. Baghdad said the Euphrates flow had fallen from a normal $920 \text{ m}^3/\text{sec}$ to $197 \text{ m}^3/\text{sec}$, endangering the lives of 3,000,000 Iraqi farmers who depended on the river for irrigation water. Over the next two weeks Iraq and Syria traded hostile statements in which Iraq threatened to take any action necessary to insure the Euphrates flow and Syria protested that it was passing on to Iraq 71 percent of the water it received from Turkey. At the end of April the Arab League formed a "technical committee" composed of representatives from Syria, Iraq and seven other Arab countries to mediate the dispute. But on May 1 Syria announced that it would not participate in the committee. A parallel Saudi Arabian effort at mediation ended on May 3 after a meeting in Riyadh with Syrian and Iraqi representatives. Throughout May the crisis worsened. On May 13 Syria closed its airspace to all Iraqi aircraft and suspended Syrian flights to Baghdad. By the end of the month Syria had reportedly transferred troops from its southern front with Israel to the Iraqi border where the Syrians claimed Iraqi forces

were missing. Other reports spoke of Iraqi threats to bomb the dam at Tabqa. As the threat of military engagement between the two countries grew, Saudi Arabia attempted another mediation effort. On June 3 the Saudis achieved an understanding in which Syria agreed to release an additional amount of water from Tabqa "from its own share" as a goodwill gesture towards the "fraternal people of Iraq...regardless of the Iraqi regime's attitude." The amount of water Syria agreed to release was not disclosed.

Although Saudi Arabia is credited with successfully mediating the Syrian-Iraqi water issue, it is likely that the Soviet Union also played an important role in defusing the conflict. The Soviets had tried to work out a solution to riparian problems on the Euphrates in their 1972 study, and it has been suggested that Syria and Iraq actually agreed to Soviet arbitration of water disputes in the same year. The Soviets had considerable prestige invested in water projects in both countries and are not likely to have wanted to see their work turned into a cause for conflict. In 1975, moreover, Soviet technicians still controlled much of the technical operations at Tabqa, giving the U.S.S.R. added leverage in the dispute.

With the resolution of the water question the threat of war receded, although Syrian-Iraqi relations showed little other improvement in the month of June. In July relations deteriorated further when Syria expelled an Iraqi military mission from Damascus and recalled its own military attache from Baghdad. Iraq made new complaints to the Arab League, charging Syria with violating Iraqi airspace and harassing and attacking Iraqi military and civilian personnel along the northern Iraq border.

It is doubtful that the April-May Syrian-Iraqi "water crisis" was a conflict over water at all. It, at least, was not primarily a conflict over water resources. This is suggested both by the lack of a crisis in the winter of 1973-74 and by the failure of the June 1975 water agreement to improve Syrian-Iraqi relations. The spring 1975 crisis was prompted by long-standing Syrian-Iraqi tensions and by rising Syrian fears of Iraqi subversion in Syria. Syrian fears were crystalized by the March 6, 1975 Iran-Iraq agreement which ended Iranian support for the Kurdish rebellion in Iraq and resolved other outstanding Iraqi-Iranian differences. Damascus feared that the rival wing of the Baath party in power in Iraq would henceforth be free to promote unrest in Syria. At the end of March the Syrians arrested between 120 and 200 Syrian members of the Baath Party said to be sympathetic to the "historic leadership" of the Baath in exile in Baghdad. Damascus accused those arrested of plotting against the government. Strident Iraqi opposition to Syria's disengagement negotiations with Israel was another factor in the conflict between Baghdad and Damascus. Damascus may have felt particularly vulnerable to Iraqi efforts to destabilize the Assad regime with the charge that Syria had sold out to Israel.

Growing Water Resource Strain:1975-2000

Water was readily removed as an issue in the Syrian-Iraqi crisis of spring 1975 as a result of Saudi and perhaps Soviet, mediation. It has not reappeared in nearly a decade to trouble relations between the riparian states. This is particularly striking in view of the markedly bad relations between Syria and Iraq since the outbreak of the Iraq-Iran war.

But are the prospects of avoiding a water resource conflict between Turkey, Syria, and Iraq in the decades ahead as bright?

Real strain on the resources of the Euphrates has not been experienced as yet. Even according actual water shortage a larger role in the 1975 conflict seems appropriate. It was at worst a temporary condition caused by the filling of the Keban and Tabqa dams. The water resource picture is just now beginning to change, however, as Syrian and Turkish irrigation works are completed, as sewage and industrial development along the river threatens to lower water quality, and as population pressures in all three countries lead to an increased demand for water for domestic use as well as for development.

Turkey, for example, is nearing completion of a series of three multipurpose dams downstream from Keban. The Turkish irrigation works are supposed to be started in 1983 and to be completed in 2005. When completed it is estimated that they will require between 17.5 percent and 34 percent of the total flow of the Euphrates at Keban. Even the lower estimate represents a drastic reduction in the amount of water available downstream in Syria and Iraq, a reduction that will not be offset by the Turkish dams' regulation of the Euphrates seasonal fluctuation.

Syria also plans to implement its Tabqa irrigation projects over the remaining decades of this century and to build a major industrial center at ath-Thawra that will consume additional water and generate effluents lowering the water quality downstream. Recent estimates suggest the Tabqa dam will permit the irrigation of 600-650,000 hectares of new land while another project along the major Syrian tributary of the Euphrates, the Khabur River, will allow 400,000 hectares to come under irrigation.

Recent experience strongly suggests, however, that these targets are far from realizable. By 1981 only 60,000 hectares had been brought under

irrigation by the Tabqa project. Land reclamations and irrigation was proceeding at a rate of less than 12,000 hectares per year, only one fifth to one quarter of the annual reclamation target. Unexpectedly high reclamation costs of between \$4,000 and \$10,000 per hectare, moreover, had already led Syrian agricultural officials to admit privately that Tabqa's ultimate goal of 650,000 hectares would probably never be reached.

The Syrian government is also concerned with controlling the amount of water used for domestic consumption. Although 60 to 80 percent of the urban areas and 20 to 40 percent of the rural areas have access to potable water, there is extreme overuse due to poor management and maintenance, resulting from broken water meters and rusty pipes. The World Bank Report of 1977 estimated that approximately 30 percent of the domestic water in Syria's nine largest cities is unaccounted for as a percentage of production. Given that the supply of potable water is not increasing as fast as demand, serious action will be needed in the next decade.

One estimate of the expected water use for all Turkish, Syrian, and Iraqi schemes actually built, under construction or planned predicts very little water surplus in years of average flow and severe shortages in dry spells of more than three to four years duration. Although both irrigation project timetables and their resultant water requirements are largely matters of conjecture, it is possible that a serious water shortage might develop and reach crisis proportions by the end of the century. What are the chances of preventing a shortage from triggering international conflict in the area?

Although the absence of a comprehensive agreement for water sharing among the riparians under all possible circumstances insures a constant risk of conflict, there are a number of factors weighing against conflict that should be appreciated. According to Turkish diplomats (in 1976) tripartite discussions on the Euphrates are continuing. Since 1975, moreover, all parties have shown an inclination to keep these talks quiet and water questions out of the sphere of their political differences. There is, also, a network of intermediaries that can help to resolve conflicts at critical points and may help the parties achieve de facto agreements through modification of their separate development plans. Saudi Arabia and the Soviet Union have been mentioned in this regard. Less important but still significant actors include the World Bank, various UN agencies and other countries supplying aid for water projects to one or more of the riparians. Finally, new water-saving technologies such as drip irrigation may substantially reduce the estimated water requirements of all three countries.

THE SHATT AL-ARAB DISPUTE

"This happy peace will last and be maintained till the day of resurrection, and whoever shall alter it after having heard it, verily this sin shall be upon those who have altered it."

--Treaty of Zuhab, 1639

The Shatt al-Arab is formed by the confluence of the Tigris and Euphrates rivers just above Basra in Iraq and carries these and the waters of a downstream Iranian tributary, the Karun, into the Arab-Persian Gulf. Since the 17th century, the Shatt al-Arab has been referred to describe a portion of the frontier between Mesopotamia and Persia, present-day Iraq and Iran.

In the past, the general state of relations between the powers of Mesopotamia and Persia has been reflected in either agreement or disagreement over their common boundary along the Shatt al-Arab. The same is true of Iraqi-Iranian relations today. The question of the Shatt al-Arab has often been related to other frontier or territorial problems, but none of the common riparian issues related to consumptive water use or water quality has ever arisen in connection with the waterway. The problem of the Shatt al-Arab is a border problem. Even navigation rights in the 19th and 20th centuries have been at issue only concerning the proprieties demand by different placements of the border, since in peace time neither Mesopotamian nor Persian powers ever sought to deny international shipping or its neighbor access to the Shatt al-Arab.

The Shatt al-Arab and Border Questions Prior to 1823

The Ottoman Turks and the Safavid Persians had fought to control Mesopotamia for over a hundred years when they signed a treaty at Zuhab in 1639 establishing peace and fixing the border between their two empires. The Treaty of Zuhab established a hundred-mile-wide frontier zone bounded by the Zagros Mountains in the east and the Tigris and the Shatt al-Arab in the west. Persian control east of the Zagros and Ottoman authority west of the Tigris and the Shatt and in Baghdad were undisputed. In between, tribal and other local leaders tried to win as much autonomy as possible by maintaining fluid relations with both powers. This was especially true in the case of the Kurds in the north and that of the Arabic-speaking population of Arabistan in the south.

The treaty of 1639 stabilized Ottoman-Persian relations for a time, but in general, fighting flared up when either side felt it could gain advantage. The chronic fighting was punctuated by treaties in 1727 and 1736. Another treaty in 1746 reaffirmed the 1639 border, but it too brought only a brief respite from Ottoman-Persian rivalry.

In 1776 the Persians succeeded in occupying Basra, leaving the port four years later only because of political turmoil back home. Another period of hostilities was ended by the first Treaty of Erzerum in 1823. This treaty reaffirmed "the stipulations of the treaty of 1746 respecting the ancient boundaries of the two Empires," thus indirectly reestablishing the vaguely defined Zagros-Shatt al-Arab/Tigris frontier zone of 1639.

British and Russian Interests and the Treaty of 1847

Within a few years of the signing of the first Treaty of Erzerum pressure began to mount on the Ottomans and the Persians to reach a precise geographical definition of their common border and to assert their authority over the autonomous tribes in the frontier zone. This pressure was the result of imperial penetration of the region by Britain and Russia.

Since 1639, when the British East India Company established an agency at Basra, Britain gradually built up its presence in the region. Its aims were to defend India against rival European powers, establish a secure line of communication to its most important imperial possession via the Middle East, and develop regional markets for its commerce and trade. The expansion of Russian influence came later, mostly in the early 19th century as the Czars fought successful campaigns against both Ottomans and Persians. By 1828, under the Treaty of Turkmanchai, Russia obtained, in addition to a considerable amount of former Persian territory, a powerful influence in Persian affairs comparable only to Britain's. By the 1830s and 40s both Britain and Russia had developed a common interest in the maintenance of the Ottoman and Persian empires as buffers helping to compose their own rival ambitions. They also had an interest in stability and some degree of effective central government in the region, as conditions conducive to the expansion of commerce and the enforcement of their treaty rights and privileges.

In 1843 Britain and Russia persuaded the Ottomans and the Persians to establish a commission to negotiate a modern border agreement. Both Britain and Russia were represented on the commission and possessed powers of mediation. The commission produced the second Treaty of

Erzerum, signed on May 31, 1847. Instruments of ratification were exchanged on March 21, 1848.

The second Treaty of Erzerum allotted the Shatt al-Arab up to its eastern (left) bank to the Ottoman Empire. Sovereignty over the Shatt was apparently not at issue in the negotiations of 1843-47. Contention focused instead on Ottoman claims to a line further east. The left bank of the Shatt appears to have been the western-most line discussed. The Shatt border was fixed in Article 2, Paragraph 3 of the Treaty:

The Ottoman Government formally recognizes the unrestricted sovereignty of the Persian Government over the city and port of Muhammara (now Khorramshahr), the island of Khizr (Abadan), the anchorage, and the lands on eastern bank - that is to say, the left bank - of the Shatt al-Arab which are in the possession of tribes recognized as belonging to Persia. Further, Persian vessels shall have the right to navigate freely without let or hindrance on the Shatt al-Arab from the mouth of the same to the point of contact of the frontier of the two parties.

About ten miles north of Muhammara the border turned northeast from the Shatt al-Arab, leaving the remainder of the Shatt upstream, as well as all of the Tigris within Ottoman territory.

The second Treaty of Erzerum opened the way for more intensive use of the Shatt al-Arab by Britain. A British company opened regular steamship service from Basra to Baghdad in 1861. Ten years later a similar service opened on the Karun tributary in Persian territory. But like its predecessors, the treaty failed to achieve a definitive resolution of the Ottoman-Persian border question. Most important to later developments, the border demarcation commission provided for in the treaty never completed its work. Representatives of the four member states began work in January 1850, but persistent Ottoman-Persian differences and continuing encroachments, as well as the Crimean War (1854-56), the Anglo-Persian War (1856-57), and finally, the Russo-

Turkish War (1876) all conspired to impede the effort. Also, in both 1869 and 1874 the Ottoman and Persian governments concluded new conventions without British or Russian mediation that were intended to resolve their continuing difficulties, but these met with no more success than previous efforts.

The 1913 Protocol

Renewed British and Russian intervention in 1913 resulted in the Protocol of Constantinople of that year. The new protocol contained a more detailed description of the frontier, provided for a new Delimitation Commission with powers of arbitration, and gave Persia (which Britain and Russia had divided into spheres of influence in 1907) several islands in the Shatt and a short stretch of territorial waters in the river.

The portion of the Shatt added to Persian territory was about a five-mile-long section from Muhammara north extending from the Persian shoreline to a point midway in the channel of the Shatt (termed in the 1913 protocol the medium filum aque). This adjustment of the frontier was prompted by the requirements of modern shipping at the Persian port of Muhammara, especially by the needs created by British oil exploration and production in the area. In 1908 a British company had discovered oil near the Karun River. The anchorage at Muhammara at the mouth of the Karun had previously been able to accomodate all ships calling there, but the new deeper-draft ships carrying oil equipment from Britain had to anchor in the Shatt al-Arab opposite Muhammara in Ottoman territorial waters. To avoid various administrative problems and possible future complications, the British pressed for the mid-channel boundary at Muhammara. A year before the 1913 protocol the British built a new port on

Persia's Abadab island seven miles below Muhammara to export crude oil and petroleum products from the adjacent refinery. At Abadan, however, the Shatt al-Arab frontier was left unchanged, and ships loaded and unloaded at the Persian port in Ottoman territorial waters.

Although the Delimitation Commission completed almost all of its work before the outbreak of World War I, Ottoman entry into the war against Britain and Russia at the end of 1914 meant that Istanbul did not ratify the 1913 protocol.

World War I to II: the Shatt Question Before the League of Nations

Between 1847 and the outbreak of World War I there is evidence that Ottoman Iraq never exercised the sovereignty accorded it over the Shatt al-Arab by the second Treaty of Erzerum. Oceangoing vessels sailing up the Shatt al-Arab, for example, used Persian pilots from Kharg Island. Other aspects of jurisdiction along the waterway are said to have been shared by the two states. The war brought about a new usage. Britain, whose troops were already in Persia with government approval, occupied the west bank of the Shatt al-Arab early in the war and the administration of the river fell under the control of British military authorities in Basra. New pilots were recruited, mainly from Basra, and navigation signs and lights were installed to facilitate the increase in shipping that came with the war. Following the war, with the former Ottoman territory now the British Mandate of Iraq, the British created the civilian Basra Port Directorate which continued to control navigation on the Shatt. Persia, ruled since 1921 by Reza Shah, made several formal protests against these unilateral arrangements, and when it finally extended

recognition to Iraq in 1929 it did so with an understanding that Baghdad would be willing to discuss the question of the Shatt al-Arab frontier.

The early 1930's, however, brought growing border tensions to Iraq and Persia, as evidenced by a series of incidents in the Shatt al-Arab and along the land frontier. Iraqi-Persian relations in this period were also troubled by border problems in the Kurdish area and by Iranian suspicion that Iraq was fomenting unrest among the Arabs in Persian Khazistan (formerly Arabistan).

In November 1934 Iraq took the Iraqi-Persian border problem to the Council of the League of Nations, alleging that Persia had failed to comply with the 1913 protocol and the subsequent decisions of the Delimitation Commission. Iraq emphasized to the League Council that the Shatt al-Arab was vital to the country's interest as it was its only outlet to the sea. In January 1935, Persia, now renamed Iran, answered Iraq's complaints by arguing that the 1847 treaty was null and void because Persia's representative some ninety years ago had exceeded his authority in signing an explanatory note to the treaty which was essential to its validity. The 1913 protocol, the Iranian government added, entailed a change in Persian boundaries, an action requiring approval by the Mejlis (parliament) which had not been obtained. Nor had the treaty been ratified by the Ottomans. As for the 1914 delimitation, it was based on an invalid treaty and was therefore itself null and void. Iraq, moreover, had in any case failed to meet its obligations under the delimitation agreement, providing additional grounds to consider it invalid. Iran suggested that the Shatt border should be governed by general international law and said that in its view the border was in fact in the middle of the river. One of the main reasons behind Iran's position was the

growing importance of the oil facilities and port at Abadan, where Iraq did not recognize the existence of any Iranian territorial waters.

Following mediation efforts by the League Council, Iraq and Iran reached an agreement, the Boundary Treaty of July 4, 1937, which they declared would settle "definitively the question of the frontier." The 1937 treaty stated that the 1913 Protocol and 1914 Delimitation would be considered valid and binding and that the border would remain unchanged except for a four-mile stretch opposite Abadan where it was agreed to move the boundary out to midchannel (termed the thalweg), as had been done in 1913 at Muhammara (now Khorramshahr). The treaty also reaffirmed that the Shatt was open to the shipping of all nations and provided for an Iraqi-Iranian commission to establish a convention within one year to regulate pilotage and navigation signals on the river. This last provision was never implemented, a fact which has added to subsequent controversy over the Shatt al-Arab.

World War II brought the occupation of Iraq and most of Iran by British troops, but no new developments concerning the Shatt al-Arab dispute. The treaty of 1937 succeeded in subduing the issue for nearly twenty years, until rising national ambitions on the part of Iran and Iraq reinforced by cold war politics once again stirred the waters of the Shatt.

Post World War II: Regional Contenders in a Bi-Polar World

The Shatt al-Arab conflict appeared in an attenuated form in 1954 when Iran complained that Iraq was not using all of the revenues collected by the Basra Port Authority (the successor to the Port Directorate) for the maintenance and improvement of the river, as Baghdad

was bound to do by the 1937 treaty. It was not until after the Iraqi revolution, however, that the Shatt al-Arab question led to major problems between Iraq and Iran.

The military coup of General Abdul Karim Kasim in July 1958 that toppled the Hashemite monarchy in Iraq added to the momentum of revolutionary Arab nationalism in the region and moved Iraq out of the Baghdad Pact and the Western sphere of influence. A little more than a year later, in November 1959, the Shah of Iran reopened the Shatt al-Arab border question by publicly demanding that the Iraq-Iran frontier along the river be moved to midchannel (the thalweg). Iranian newspaper at the same time asserted Iranian rights to sovereignty in the Kurdish areas of Iraq. Iran and Iraq shifted military forces to their border. Iran unilaterally appointed Iranian river pilots to guide vessels sailing up the Shatt al-Arab, a measure which the Iranians were forced to rescind later when Iraq's refusal to cooperate with the Iranian pilots led to the closing of Abadan for nine weeks in 1961. While Iraqi-Iranian tensions over the Shatt al-Arab persisted and the border question remained the central issue in the two countries' relations, the conflict did not grow worse until 1968 and 1969 following a change of government in Iraq and in the context of an American-backed Iranian drive for supremacy in the region.

The Baath Party came to power in Iraq in July 1968, bringing a measure of internal stability to the country after a decade of political turmoil. A more stable Iraq under the leadership of the pan-Arab socialists of the Baath was viewed by the Shah of Iran as a new threat to Iranian security and ambition in the area. The Shah was particularly concerned about a possible Baathist alliance with the increasingly restive Arabs in Iranian Khuzistan. The Shah's response to the advent of the

Baathists in Baghdad was to increase Iranian support to the long-standing Kurdish nationalist struggle in Iraqi Kurdistan just as the Baathist government was attempting to reach a negotiated settlement with the Kurds. Soon afterwards, in April 1969, Iran unilaterally abrogated the 1937 treaty and announced that it recognized the thalweg as the international frontier in the Shatt al-Arab.

These Iranian actions came as the country was seeking to expand its role in regional affairs, partly to fill the vacuum to be created by the British military withdrawal from the area (and all areas "east of Suez") planned for 1971. Growing oil revenues and American military aid and political encouragement enabled the Shah to attempt to increase Iranian influence in the Persian Gulf. Iraq, which was turning more and more to the Soviet bloc for international support, was the most serious obstacle in the way of Iranian hegemony.

Border clashes between the two countries erupted in April 1971 and became a chronic occurrence over the next four years. Iranian support for the Kurdish rebels continued, exacting a heavy toll on Iraqi military and economic resources. In February 1974, Iraq took the border dispute to the UN Security Council. Iraqi-Iranian negotiations began and agreement was finally reached at a meeting in Algiers between President Saddam Hussein of Iraq and the Shah of Iran on March 6, 1975. The resultant treaty was signed in Baghdad on June 13, 1975. The Algiers agreement entailed an end to Iranian support for the Kurdish rebellion in return for Iraqi acceptance of the thalweg principle in the Shatt al-Arab border. Beyond this, the 1975 accord represented Iraqi acquiescence, however reluctantly given, to Iran's superior power and new preeminence in the region.

The 1975 treaty lasted as long as Iranian hegemony in the Gulf. Iraqi dissatisfaction with the treaty began to be expressed shortly after the Iranian revolution forced the departure of the Shah from Iran in February 1979. October 31, 1979 Iraq issued a statement through its ambassador in Beirut demanding the abrogation of the 1975 treaty, the evacuation of three small islands in the Persian Gulf seized by Iran despite Arab protests in 1971, and autonomy for Arab, Kurdish and Baluchi minorities in Iran. Iran formally rejected these demands. An eleven-month period of escalating incidents followed, ending in full-scale war between Iran and Iraq. As early as December 1979, for example, Tehran claimed that Iraq had shelled an Iranian border post and advanced its forces three miles inside Iranian territory. In April 1980 Iraq sent a drawal from the three Gulf islands and began deporting thousands of Iranian nationals from Iraq. Iran placed its army on full-alert and Iranian revolutionary leader Ayatollah Ruhollah Khomeini called for the overthrow of Iraqi President Saddam Hussein, whom he termed an "enemy of Islam and Muslims." In radio broadcasts Khomeini urged the Iraqi people to rise against the Baathist government in Baghdad. Border incidents grew into continuous border fighting in the spring and summer. Finally, on September 21, 1980, Iraq launched a major military offensive into Iranian territory, initiating full-scale war with Iran. Four days earlier, on September 17, Saddam Hussein had announced Iraq's unilateral abrogation of the 1975 treaty and reestablishment of Iraqi sovereignty over the entire Shatt al-Arab waterway.

Conclusion

Throughout its long and varied history, the Shatt al-Arab dispute has been more the symptom than the cause of hostility between the powers on its opposite banks. Few practical problems have ever arisen in the course of the dispute. The two major adjustments required by modern and more intensive usage – the creation of Persian territorial waters off Muhammara in 1913 and the application of the "Muhammara principle" to Abadan in 1937 – were accomplished without any material loss to Iraq. The Shatt al-Arab conflict in the present era is a reflection of the struggle of Iraq and Iran for regional supremacy. In the late 1960's and 1970's Iran succeeded in gaining the upper hand and was able to compel Iraqi acquiescence but could not, as subsequent events have shown, win Iraqi consent to this state of affairs. Iraq's own bid for regional dominance, made in the wake of the turmoil created by the Iranian revolution, has already gone awry. Even if it had met with greater initial success, it is doubtful that it would have resolved for very long either the Shatt al-Arab dispute or any other issue in Iraqi-Iranian relations.

The superpower rivalry that played an important role in Iran's drive for hegemony under the Shah has been largely neutralized or at least confused by the Iranian revolution. An element of intense ideological conflict between secular Iraq and fundamentalist Iran has now been added to the conflict, however, making it less susceptible to solution than ever before.

A successful resolution of the Shatt al-Arab question will necessarily have to be part of a framework to compose the whole range of Iraqi-Iranian concerns. Perhaps this might be accomplished at a future and more propitious date through a regional security agreement in the

Gulf. The United States and the USSR could play a role similar in its positive aspects to that of Britain and Russia in an earlier era by underwriting such an agreement. Stability in the area would be achieved in this case not by promoting the ascendance of either Iran or Iraq in the area, a course for which history holds out little hope of success, but by limiting the ambitions of both regional powers and at the same time guaranteeing the interests of the weaker states in the region.

TECHNICAL ASPECTS OF EUPHRATES -- Shatt al-ARAB

Water Quality

The headwaters of the Euphrates River provide a water which is of reputedly high quality. Data are not available to quantify this, although van Aart states that irrigation waters used in the lower part of the Euphrates average 300-500 ppm salinity, and that the river water in the south may reach 600 ppm. Cressey reports that the salinity of the Euphrates averages about 250 to 445 ppm. However, the use of the water for irrigation purposes upstream attests to its quality. In the estuary region located south of Basra, the salinity levels are naturally much higher. This is especially true at high tide in the autumn when the flow is lowest. During such periods, the salinity is typically over 5000 ppm. Talling presents groundwater data for the basin at stations located at Musaiyib on the Euphrates and at El-Zubeir on the Shatt al-Arab. These data indicate very high concentrations of dissolved ions, especially sodium, magnesium, chloride, and sulfate. He also presents data showing the salinity of the river increasing from 160 to 525 ppm over the seasonal cycle as measured at Samawa, about 220 km above Qurna. Other data presented by Talling show electroconductivity increasing from 575 micromho/cm at Qaim to over 900 micromho/cm at and below Samawa. Edaphic factors in the lower basin contribute naturally to a reduction in water quality as the river moves downstream. In this regard, it is important to note that the flooding of the Abu Dibil depression by the Iraqis in the 1950s resulted in a degraded water because of the rapid evaporation rate and the high salt content in the soils of the depression.

The lower part of the Euphrates, including the Shatt al-Arab, is naturally prone to the problems of salination. This results from a combination of poor drainage, centuries of irrigation, and natural soil factors. The salt content of the upper groundwater ranges from 7000 ppm in the central part of the Lower Mesopotamian Plain to 30,000 ppm in the south.

Sediment is a water quality issue in the Shatt al-Arab. Although much of the silt load of the Tigris and the Euphrates settles out in the Inland Delta above Basra, the full load of sediment in the Karun enters this waterway. The total sediment entering the Shatt al-Arab is measured in millions of tons per year.

As noted in the following discussion, the three riparian states have extensive plans for developing the waters of the Euphrates. These plans are expected to mature and be implemented over the next twenty years. The intended results of the plans are increased irrigation, an expanded industrial base, and meeting the needs of an increasing population. An unintended result will be the certain degradation of the quality of the water in its lower reaches. This will undoubtedly render the water progressively less fit for use by the Iraqis. It is not unreasonable to expect that the lower part of the Euphrates will experience a degree of reduction in water quality proportional to that observed in the River Jordan in recent decades.

There is also emerging evidence that the dumping of untreated sewage into the Euphrates is causing serious health problems. A World Bank report of 1977 stated that there are a number of waterborne diseases caused by inadequate sewage treatment. Schistosomiasis is beginning to appear on the Khabur and Balikh Rivers (tributaries of the Euphrates);

there have been numerous outbreaks of cholera in recent years. In an attempt to avoid these health problems, Syria has built sewage treatment plants in Al-Raqqa, Aleppo, and Deir ez-Zor.

Water Development Plans

The three riparians, Turkey, Syria and Iraq have all formulated plans and implemented projects over the years to achieve flood control on the Euphrates and to use its waters for the generation of hydroelectricity and large-scale irrigation. Little effort has been made to coordinate the planning of the three entities, and no formal agreement has been reached regarding the allocation of the water to riparians.

The Hindiya dam was completed in 1913. This barrage is located in Iraq and it represents the earliest of the modern developments on the Euphrates. The purpose of the Hindiya was to divert water to reconstructed irrigation canals, including the al-Hillah irrigation channel. In the 1950s, a second dam was built at ar-Ramadi. This project was designed for flood control and it permitted flood waters to be impounded in Lake Habbaniyah and the Abu Dibis depression. The soils of the depression proved saline and this resulted in a degradation of water quality and the scrapping of irrigation plans. A third dam has been constructed further upstream, above ar-Ramadi and Hindiya. It was completed in 1982 and is intended to damp seasonal fluctuations in flow and probably also to provide irrigation water.

Syria has achieved a considerable growth in irrigated land over the past three decades, and reserves of cultivable rain-fed lands have almost been depleted. Given the experience of economic growth in Syria, and its anticipated continuation, an expansion of the amount of irrigated

land is a necessity. During the immediate post-World War II era, this was achieved in the Orontes. Further expansion of irrigation requires more complete use of the Euphrates and the Khabur. Costly irrigation systems will be required for both rivers, because each flows in a narrow deep channel. Plans for the Khabur include the construction of additional dams downstream from Tel Mahafy at Saab, Skouhar and At-Taaf to irrigate approximately 120,000 hectares. On the Euphrates, an earthen dam has been constructed at Tabqa (ath-Thawrah). The dam was completed in 1973. The lake behind this dam stores approximately 40,000 MCM which is used to irrigate the Raqqa plateau above the east bank of the river, and the district of Resafe on the west. The amount of irrigated land is about 550,000 hectares.

Turkey has plans to make extensive use of the waters of the Euphrates River for hydroelectric generation and for irrigation. The first interest shown by Turkey in the Euphrates was as a hydroelectric source. The Keban dam, completed in 1973, was designed to produce electricity and to attenuate the seasonal peaks in the flow regime of the river. The dam is 200 m high and forms a lake 115 km long behind it. The power plant has an installed capacity of 620 MW. The Keban is designed to provide a minimum discharge of 450 m³/s and to almost completely prevent discharges greater than 1000 m³/s. The lower Euphrates project anticipates the irrigation of about 80,000 hectares from groundwater in that river basin.

Turkey also has plans for three additional dams below the Keban. These are advancing towards completion, although the final date is unknown. The dam at Karababa is intended to supply irrigation water for 300,000 hectares in the Urfa, Harran and Lower Mardin plains and to an additional 400,000 hectares in the Siverek-Hilvan, Upper Mardin and Nusaybin-Cizre areas. (This dam is located furthest downstream, the

others, the Karakaya and the Bolkey, being designed for hydropower.) The start-up date for the Turkish irrigation works was reported to be 1983, with a construction period of about two decades. When completed, it is projected that the irrigation system will require between 17.5 percent and 34 percent of the total flow of the Euphrates River at Keban. This will result in a significant reduction in the river's flow which will not be compensated by the seasonal flow regulation of the dams.

Given the proposed development schemes of each of the three users of the Euphrates, it is apparent that in the near future the waters of the river will be completely utilized. In fact, Beaumont has stated that successful completion of all the planned projects will lead to a very small surplus (or even a small deficit) of water in average flow years, and severe shortages in drought periods. The anticipated completion dates of these projects are subject to conjecture and some doubt; however, it is reasonable to assume water shortages in the basin by the end of the present century.

Redistribution of Water

The present patterns of use in this basin, and the projected future development of water resources in the Euphrates Valley, although extensive in their scope, do not include the transfer of water out of the drainage system.

Water Usage

Turkey makes use of the upper reaches of the Euphrates primarily for the generation of electricity via hydroelectric stations. In the future,

this may change as there are in existence Turkish plans for making greater use of the stream, particularly for irrigation purposes.

The waters of the Euphrates and its major tributary, the Khabur, are used primarily for agricultural purposes in Syria. The Syrian economy has grown substantially during the past 40 years, and much of this growth has been attributed to increased agriculture. According to Beaumont, water from the Euphrates for irrigation purposes amounted to 3000 MCM per year in the late 1960s. The implementation of the Tabqa irrigation projects over the next two decades will accentuate this trend. It is estimated that the Tabqa dam will provide irrigation water for over 600,000 hectares, and that further development of the Khabur will bring another 400,000 hectares under irrigation. Additionally, Syria plans to develop this area as an industrial center.

Data are not readily available to document Iraq's use of the Euphrates. Bari states that little agriculture is supported in the al-Jazira region in Iraq, in spite of the potential fertility of the soil. The bulk of Iraqi agriculture is based in central and southern Iraq in the region around Baghdad and south of it. Barley, rice and dates are the staple foods. However, Beaumont indicates that the water withdrawn by Iraq has risen from 27.3 percent of mean flow in 1940-1949 to 45.1 percent in 1960-1969. Most of this increase of approximately 65 percent (in twenty years) is attributable to expanded agricultural irrigation. Gischler indicates that 48 percent of the cultivated land is under irrigation and that 80 percent of the irrigated land is affected by salinity.

Water demands in the basin will undoubtedly continue to grow. The population growth in the three riparian states has averaged around three percent per year. The increasing population will produce a proportional

demand for electricity, agricultural production and industrial production, all of which in turn will place a strain on the water resources of the region. For example, the Ministry of Planning for Iraq expects the amount of surface water extracted in 1995 from surface sources for potable and industrial uses to be ten times the amount used in 1975 (increasing from 1553 to 10,425 MCM per year). Whether accurate or not, the projections help to anticipate stress that will be placed on the water sources of the region in the near future.

Overview of Present Status

The use of the Euphrates system by the Syrians and Turks has serious international consequences. Of particular concern is the downstream riparian, Iraq. Continued use of the Euphrates for irrigation will lead to degraded water quality in the Euphrates which will adversely affect the use of the water in Iraq. The other ramification is that increased use upstream by Turkey and Syria will reduce the flow in the river because the major use of the water is for irrigation which of course is a consumptive use.

Indeed, the three riparians have held discussions regarding the use of the Euphrates. Such discussions have been kept secret, and the negotiations have been linked to other watersheds (the Orontes) and to other issues. Although the data are not available, it is apparent that the riparians have had great difficulty reaching an accord with respect to allocation of the flow of the Euphrates. In view of the competing plans for the further development of the Euphrates River mentioned above, it is apparent that an agreement among the users will be required to prevent disagreements over the next twenty years.

THE ORONTES RIVER

HYDROLOGY OF THE ORONTES RIVER

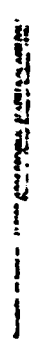
Limitations of the Database

The Orontes is the river for which we have been able to locate the least information. A high priority of any follow-up study must be to acquire more information about the basic hydrology of the Orontes system. The most recent study we have identified, that of Metral, lists important sources in the bibliography in a form that defies all efforts to locate them. In particular, the doctoral thesis of Weulersse and the contribution of Re would be valuable. The information presented here is primarily from Metral and Wolfart.

Natural Regime and Discharge

The headwaters of the Orontes rise a few kilometers northeast of the headwaters of the Litani River, in the floor of an alluvial valley that is a structural and morphological extension of the Bekaa Valley. In both valleys, the principal streams are fed by surface runoff from the Lebanese Mountains on the West and the Anti-Lebanon Mountains on the east, and from the ground-water that enters the streams from the thick upper Tertiary alluvial fill on the valley floor, maintaining base flow in times of diminished runoff. The highest elevations on the Lebanon Mountains in northern Lebanon receive 1,000-1,600 mm of rainfall/year. The Orontes Valley itself receives on the order of 700 mm/yr in its upstream reaches, while the Anti-Lebanon Mountains east of the river receive only about 500 mm/yr.

SYRIAN ARAB REPUBLIC



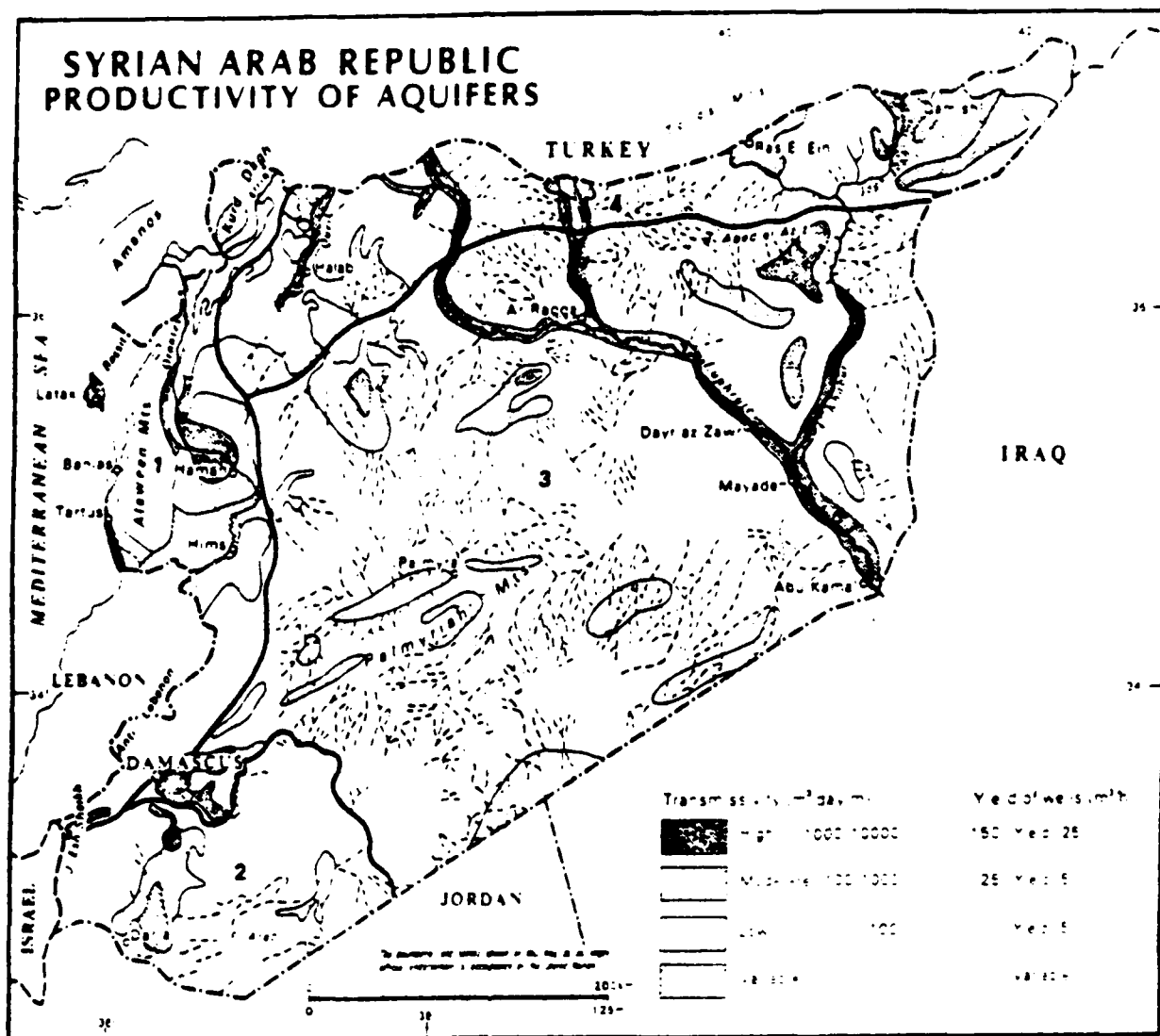
The Orontes flows in Lebanon for about 35 km (see Fig. XX), where it is known as the Nahr al-Assi (the rebel stream). The Orontes enters a flat plain underlain by Quaternary alluvium as it crosses into Syria. Along the Western margin of that plain, constrained by the shoulder of a basalt massif that extends eastward from the Lebanon Mountains (known as the Alaween Mountains in Syria), it flows into the Homs Lake and, a short distance downstream from the lake outlet, flows through the Syrian city of Homs, the center of a modern irrigation development scheme. The river describes a broad loop around the basalt massif that extends eastward from the Lebanon (Alaween) Mountains, and then flows across a low-relief terrain underlain by upper Cretaceous limestones, through the Syrian city of Mana, through the canyons at Cheizar, and into the plain of Asharneh, which lies east of the northward extension of the Lebanon Mountains.

Between Asharneh and Karkour the Orontes traverses the broad flat Ghab Valley (62 x 12 km), underlain primarily by Pleistocene limestones. The Orontes leaves the Ghab Valley over a mass of resistant basalt before it enters Turkey in a basin underlain by Tertiary sediments; it turns southwest abruptly at its confluence with the Afrine, which rises on the slopes of southern Turkey and flows south in the valley east of the Kurd-Dagh Mountains in extreme northwest Syria. From that confluence the Orontes flows directly to the Mediterranean, between the Kurd-Dagh Mountains on the north and the Alaween Mountains on the south, remaining in Turkey for the last 50 km of its course. The Orontes forms, for approximately forty km of its length, a part of the 1939 border between Syria and Turkey. It ends its meandering 610-km course at the Mediterranean near Antioch.

The mean discharge of the Orontes at Cheizar, the head of the elaborate irrigation installations of the Ghab Valley, is 25 cubic

meters/second, or 790 MCM/yr. This flow is variable, ranging from 40 percent of that value during dry seasons of dry years or eight times that value during major floods produced by heavy winter rainfall. The river's discharge reaches a peak in February and March and declines steadily in late spring and summer. In January, after winter rains have had nearly two months to replenish its underground sources, its flow rises abruptly from the low level of the late summer and fall.

The annual discharge of the Orontes varies with the rains. Until the recent construction of dams along its middle course in Syria, years of heavy rainfall brought disastrous flooding to many areas along the river's banks. The flow of the stream is perennial, however, due primarily to ground-water recharge from the complex of permeable materials that underlies the river along much of its course. An additional 250 MCM/yr enters the lower Orontes via its major Turkish tributary, the Afrine.



HISTORY OF THE ORONTES RIVER

Traditional Use

The perpetual creaking and groaning of the norias on the Orontes at Hama are evidence of the river's exploitation for irrigation since antiquity. Some of the two-story wooden waterwheels that use the force of the river's flow to lift its waters into aqueducts date from the 16th century. They and others of more recent construction are built on Roman and Byzantine models.

In addition to the norias and aqueducts of Hama, small-scale canal works at many points along the river's course have permitted irrigated agriculture for centuries. The Ghab depression north of Hama possessed an elaborate irrigation and drainage system under the Seleucids that persisted to late Medieval times, when the gradual spread of marshland and malaria forced the abandonment of the Ghab except for buffalo breeding and catfishing.

Modern Development

The advent of mechanical pumps has made it possible for individual landowners in Lebanon, Syria (and Turkey) to supplement their traditional use of the Orontes with wells that tap the river's subterranean aquifers, but modern development of the river on a large scale has been limited to Syria.

Studies by French Mandatory authorities in the early 1930s recognized that the potential of the Orontes in Syria was second only to that

of the Euphrates. Plans drawn up then by the Regie des Etudes hydrauliques envisioned the development of three areas along the Orontes: the stretch of the river from Homs to Hama, the Ghab, and the Amuq plain (then part of Mandatory Syria prior to the French cession of the province of Alexandretta to Turkey in 1939). Work to enlarge the capacity of Lake Homs and to build a canal from Homs to Hama permitting the irrigation of 20,000 hectares was carried out in the late 1930s. In the same period Mandate authorities gave serious consideration to developing the Ghab to resettle Assyrian refugees from Iraq and Iran, but this scheme was abandoned for political reasons in 1937.

The Syrian government revived plans to develop the Ghab with the creation of the Ghab Project Organization in 1951. A Dutch firm designed the system and construction of the project's primary installations was carried out from 1955 to 1967 with the help of Bulgarian, Yugoslav, Italian and other companies. The Soviet Union supplied materials for the project, while most of the financing was provided by Syrian capital.

The Ghab project covers an area of 140,000 hectares including (from south to north) an area along the Orontes between Rastan and Hama; the plain of Asharneh some 25 km north of Hama at the entrance of the Ghab depression; and the Ghab proper, a 60 by 10 km graben between the Alawite (or Ansariyyah) massif in the west and the Zawieh mountains in the east. Approximately 80,000 hectares of this area are cultivatable, of which 70,000 are irrigated by the project; 30,000 hectares are reclaimed swamplands in the Ghab depression.

Two large drainage canals running the length of the Ghab (one replacing the meandering bed of the Orontes), a dam with a 250 MCM capacity at Rastan, another with a 65 million MCM capacity at Hilfaya-Mehardeh (20 km north of Hama), and a concrete weir at Asharneh diverting water to two

irrigation canals comprise the Ghab project's major water works. All were completed by 1961. The primary drainage and irrigation network was completed in 1963, while most of the secondary (56 km) and tertiary (552 km) installations, carrying water to and from individual plots, were in place by 1968. Extension and adjustment of the system, however, has continued to the present. A dam on the Sarout is planned to permit greater storage of this tributary's exceptionally high peak flow in winter. In addition to the land reclamation and irrigation made possible by the Ghab project, a large generator at Rastan and a smaller one at Mehardeh provide electricity to the entire Homs-Hama area.

Although the Ghab project's impact on the Syrian economy as a whole has been relatively slight, it is an important demonstration of the government's social development policies. The population of the project area was estimated at 30,000 in 1952. Today, after a government-sponsored resettlement program, it is more than 150,000. Land reform laws enacted in the late 50s and 60s have resulted in the expropriation of approximately 11,000 hectares of irrigated land in the project area and its redistribution to landless peasants and small holders (24,000 hectares of irrigated land remain in the hands of their previous owners). Nearly 90 percent of the recipients of reclaimed or expropriated land are members of some 50 agricultural cooperatives established by the government. A special administrative unit and the Ministry of Agrarian Reform plan and direct production in the Ghab area to meet needs for industrial and commercial crops (cotton, sugarbeets, wheat and other cereals). The government aims to eliminate in the Ghab area the two traditional figures of the Syrian countryside: the absentee landlord and the improvised

peasant. In their place it wishes to build a new rural society: egalitarian, scientific, and prosperous.

The Syrian investment in and dependence on the Orontes is thus quite considerable. The river generates electricity for two of the country's main cities, provides water for domestic consumption and extensive irrigation, and makes possible a model development project exemplifying the government's fundamental economic and social ideas.

TECHNICAL FEATURES OF THE ORONTES RIVER

Water Quality

Specific water quality data for the Orontes are not available. The otherwise excellent paper by Metral makes no explicit mention of water quality issues. However, extensive agricultural use is made of the water in the upper reaches of the river. As noted elsewhere, the principal crops include cotton, sugarbeets and cereals. Based on this indirect evidence, it is concluded that the quality of the Orontes is high.

While the water seems, on the evidence, to be sweet, there are indications that problems exist because of domestic and industrial effluents. Lake Qatina south of Homs serves the needs of several large industrial installations, but the Orontes is no longer exploited as a public water supply for large communities. World Bank reports urge improved sewerage treatment for Hama and Homs, as well as other urban centers. Water-borne diseases such as typhoid and dysentery are endemic in the lower reaches of the Orontes; there have been several cholera outbreaks in Syria in recent years in areas where sewage water is used for contact irrigation. In Hama province, it is estimated that, among the villages depending upon the river for water supply, 90 percent of the diseases contracted by villager are waterborne. The Arab Fund for Economic and Social Development granted Syria a loan of 5 million Kuwaiti dinars in 1982 to finance water networks in Hama and Homs.

Redistribution of Water

There are no large scale inter-basin transfers of the waters of the Orontes. The use of this river is accomplished by storage reservoirs, hydroelectric generation, and a system of canals for local irrigation purposes.

OVERVIEW OF PRESENT STATUS

Although it is an international river, the Orontes has not appeared as a significant issue in regional politics to date. The absence of conflict over the Orontes stems from two facts: the river's relative unimportance to both Lebanon and Turkey, and the distribution of major sources or tributaries among all three riparian states.

The Orontes is a major lifeline for Syria, traversing the length of the heavily populated areas parallel to the country's Mediterranean coast and passing through its third and fourth largest cities. It does not have a similar importance for either Lebanon or Turkey, where its course is short and runs through areas that are well-supplied with water sources. In Lebanon the river rises to traverse a distance of only 40 km. before reaching the Syrian border, while in Turkey it covers just 60 or 70 km. before emptying into the Mediterranean. Ample water is available for Lebanese use in the northern Bekaa without reducing the Orontes' flow to Syria's detriment, while in Syria, as already mentioned, the river is augmented by the Sarout and many springs in the Ghab. In Turkey, the Amuq plain is watered by the Kara Su and several smaller streams as well as the Orontes.

There is a third factor that would contribute to stability even if Lebanese and Turkish interests in the river were greater. An "inverse symmetry" exists between the position of the three states along the river and their position in terms of military power. Farthest upstream is Lebanon, militarily the weakest state; next is Syria, whose army is far more powerful than Lebanon's; and downstream from Syria lies Turkey with

a military capability superior to Syria's. This would seem to be a especially stable situation since an upstream state, which has the potential to make preemptive use of the river, must consider the possibility of reprisals by its more powerful downstream neighbor.

While the potential for riparian conflict over the Orontes among the three states is virtually non-existent, the river is a factor in broader Syrian-Turkish discussions of water issues. And, according to one report, Syrian officials have also mentioned concern over future access to the waters of Orontes as a consideration in their policy toward Lebanon and Israel.

Turkey has proposed to include the Orontes in its discussions with Syria on the sharing of the Euphrates river waters. The Turks hope by reaching a formal agreement on the Orontes to obtain de jure Syrian recognition of Turkish sovereignty in the disputed province of Alexandretta. The Syrians are not likely to drop their long-standing claim to Alexandretta for an agreement on the Orontes, or even for an agreement on the Euphrates, which is much more in their interest. At the same time they are unlikely to try to reignite the Alexandretta question. (In the late 1960s, for example, Syria reached an agreement with Turkey on compensation for Syrian property in Alexandretta confiscated by Turkey and Turkish property in Syria nationalized by the Syrian government.) Least of all is Syria likely to tamper with the Orontes as a means to press Turkey on Alexandretta since to do so would be to risk highly damaging retaliation by Turkey on the Euphrates.

Syrian officials have reportedly said that fear of a possible Israeli presence at the source of the Orontes is one of their reasons for refusing to withdraw their armed forces from Lebanon. Since Ain Zerqa,

the principal Lebanese source of the Orontes is 75 kms from Israel's maximum penetration of Lebanon in 1982 and even farther from present Israeli lines, this is hard to credit. Moreover, an Israeli military presence at Ain Zerqa would imply a regional upheaval of such proportions that even the most urgent water issues would assume relative insignificance.

In sum, it would be hard to design an international river system in a generally water-scarce part of the world less prone to conflict than the Orontes. Graced by its multiplicity of sources and its marginal significance to its uppermost and lowermost riparian partners, it is not likely to trouble the region.

THE NILE RIVER

HYDROLOGY OF THE NILE RIVER

The Nile is the longest river system in the world. It flows 6,695 km from a source in Burundi to its mouth at the Delta in Egypt. The Nile drains 2,978 million sq km, almost one tenth of the land area of Africa. Although it is the longest river in the world, the drainage basin of the Nile is only the fourth largest (after the Amazon, Mississippi, and Congo), and at least 32 major rivers carry more water in the course of a year.

Sources of the Nile

The most distant source of the Nile rises in a rain forest near the Equator. From here the river flows north, passing through sub-tropical savannah terrain in the southern Sudan and traversing the width of the Sahara before entering a semi-arid Mediterranean climatic regime in the last few hundred kilometers before its discharge enters the Mediterranean. No other river crosses so many different climatic zones; no other river flows so far (2,000 km between Khartoum and the Delta) without receiving any perennial tributaries (see Figure 8).

The Lake District: Precipitation in the Lake District, the headwater region of the White Nile, averages 1,500 mm/yr; it is distributed in two prominent rainy seasons, at times when the Inter-tropical Convergence Zone lies across the Equator and for a few months after the March and September equinoxes. The head of the Nile is represented by a large number of streams that drain the highlands of the polygon of land con-

tained between the two branches of the African Rift system in East Africa. These streams flow into Lake Victoria, a broad, shallow body of water that is the second largest (in terms of area) fresh-water lake in the world. Lake Victoria drains to the north over Ripon Falls (now inundated under water held back by the Owen Falls Dam) and flows into Lake Kioga, another broad, shallow lake perched on the eastern rim of the western rift. Lake Kioga is clearly a prior dendritic drainage system in which drainage has been reversed as the rim of the rift was tilted eastward as a consequence of foundering of the rift floor.

The Nile escapes out of the west end of Lake Kioga and plunges down a very steep slope that includes the dramatic gorge of Murchison Falls onto the floor of the western rift, where it enters the north end of Lake Mobutu (Lake Albert), an extremely deep lake whose configuration is controlled by the normal faults of great displacement along either side of the rift. Another arm of the upper White Nile enters the south end of Lake Mobutu, having passed through Lakes George and Edward. The residence time of Nile water in the great volume of Lake Mobutu is very long. The Nile (as the Bahr el Jebel) leaves the north end of Lake Mobutu only a few kilometers west of the entrance of the outlet of Lake Kioga, and flows down an abruptly decreased gradient onto the alluvial plain of the central Sudan. The lowest relief portion of this is represented by the enormous swamps choked with islands of floating vegetation known as the Sudd, the largest fresh-water swamp in the world. The Bahr el Ghazal enters the Sudd from the west, and the Sobat flows into the swamp off the southwest flanks of the Ethiopian highlands.

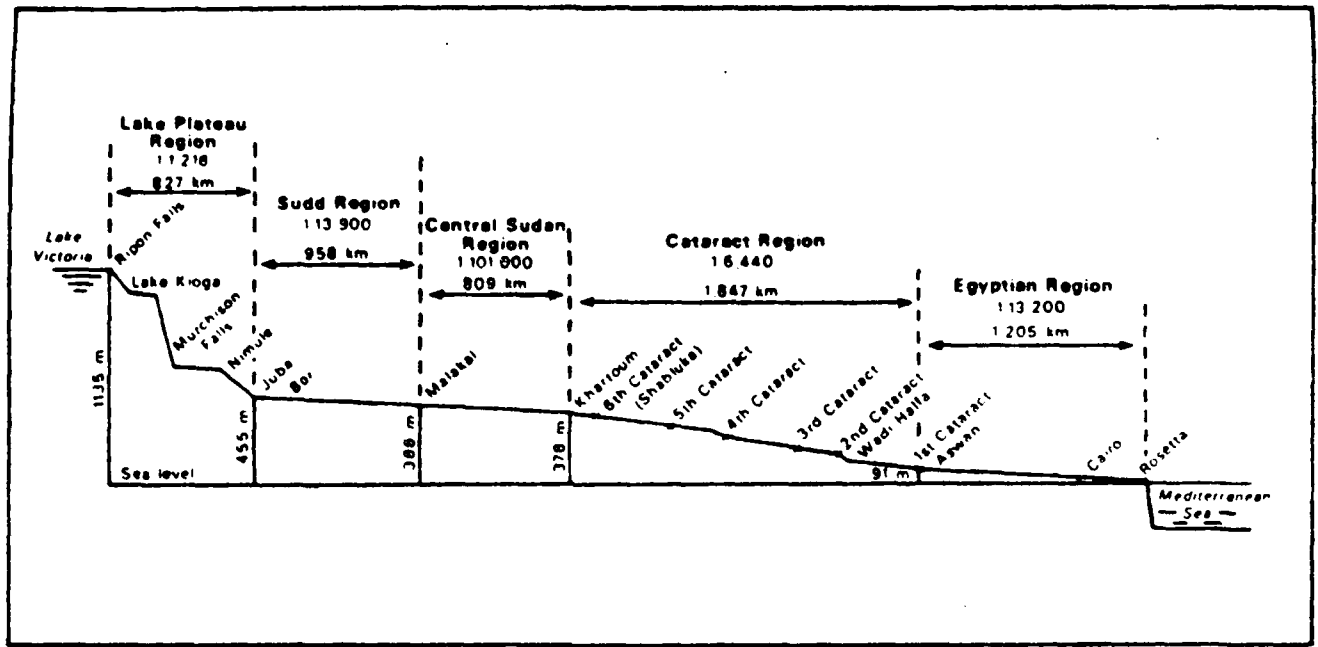
The White Nile and Blue Nile: The White Nile leaves the Sudd and flows across progressively more arid terrain to Khartoum, where it is joined by its principal tributary, the Blue Nile. The Blue Nile rises

from Lake Tana, high on the volcanic tableland of Ethiopia, and joins the White Nile after traversing an awesome canyon that was not fully explored until 1968. Below Khartoum the Nile enters the stretch of the six cataracts; the Atbara River, an intermittent tributary that periodically carries a large discharge, enters the combined Nile system 322 km downstream of the confluence of the White and the Blue Nile. Below the mouth of the Atbara, the Nile receives no further inflow (except for the runoff from the extremely rare desert storm) until it reaches the Mediterranean, even though its course is marked by many well-developed tributary wadis that bear testimony to very different local climatic regimes in ages past.

Rain falls on the upper White Nile throughout the year, but the periods of discharge follow the equinoctial rainy seasons. Lake Victoria receives 16,000 MCM/yr surface runoff from its various tributaries, and 98,000 MCM/yr in direct rainfall, of which 93,000 MCM/yr is directly evaporated. Outflow from Lake Victoria is 21,000 MCM/yr, which is increased to 22,000 MCM/yr at the outflow of Lake Albert. The Sudd receives an annual inflow of 27,000 MCM/yr from its several riverine sources, and a much greater supply of direct rainfall, primarily at and shortly after the June solstice, when the Intertropical Convergence Zone lies at its most northerly position. The combination of effective evaporation and transpiration by swamp vegetation reduces the outflow of the Sudd via the White Nile to 14,000 MCM/yr.

The Blue Nile is fed by the torrential monsoon rains that fall over the Ethiopian Plateau as a result of warm, moist air masses that are drawn off the Indian Ocean by the Southeast Trade Winds into the convective system of the Intertropical Convergence Zone at and after the June

Slope of the Nile from Lake Victoria to the Mediterranean



solstice. The Blue Nile carries 48,000 MCM/yr. primarily in the late summer flood, during which the White Nile may be ponded up above Khartoum to the foot of the Jebel Aulia Dam. The Atbara contributes an additional 12,000 MCM/yr. also during the summer monsoon. The Aswan Reservoir receives, then, an annual inflow from these sources of 84,000 MCM/yr. (The Sudd inflow accounts for 24,000 MCM/yr of which 10,000 is lost by evaporation over the surface of the lake). Below the Aswan High Dam the 84,000 MCM/yr is further reduced by evaporation and infiltration through the bed of the river to the ground-water system, and is vastly reduced by the consumptive use of irrigated agriculture.

Basic Characteristics of the System: The Nile clearly consists of a number of distinct segments in which the basic character of the river system (and, by most accounts, its recent geologic history as well) undergoes marked changes. In the Lake district, the gradient is highly variable, but averages 1: 1.216 between the highest sources and Juba. This steep average gradient and its extreme variability is the result of the rapid and high-amplitude earth movements that have occurred in the most recent episodes of development of the rift system. Dramatic changes in the geometry of the river system in this segment are clearly in progress: without the intervention now represented by the several flow-control devices along the upper Nile, both Lake Victoria and Lake Kioga could expect to be captured by headward migration of falls not far down their outlets. The development of emerged shorelines along the west shore of Lake Victoria and their absence from the east shore clearly show that the basin of the lake is currently being tilted to the east, a displacement that neatly explains the configuration, location, and size of Lake Kioga.

Below Juba, the Nile undergoes a marked change in regimen, where its gradient is reduced to 1:13,900 where it flows across an alluvial plain above the Sudd. Within the Sudd itself its gradient is not measurable; the history of river navigation through the Sudd is a frustrating story of lost river boats, channels periodically blocked by massive islands of floating vegetation, and delays in some cases amounting to months as pilots sought clear passages through the morass. The current is no help since it, too, is effectively reduced to zero where the White Nile discharge passes through the Sudd. Below the Sudd the White Nile falls only 8 m in the 809 km above the junction of the Blue Nile at Khartoum, representing a phenomenally low gradient of 1:101,000. The Blue Nile rises an average of 7 m in the annual flood; before the construction of the dam at Jebel Aulia the White Nile above Khartoum was ponded for 700 km above the confluence at times of flood.

The courses of the Blue Nile, Atbara, and Upper Sobat, like the course of the White Nile in the Lake District, are steep and in a state of present adjustment in response to high-amplitude tectonic displacements of the rocks across which they flow.

The gradient of the combined Nile below Khartoum is irregular. The river falls 287 m in 1,847 km above Aswan, much of which is accomplished in the six cataracts, located on masses of crystalline bedrock, the basement of the African craton, that merge through the cover of younger sediments.

Below Aswan (and the First Cataract), the Nile again flows on alluvium, here across a filled valley deeply excavated by an ancestral Nile in times of low Mediterranean sea levels. The gradient of this segment of the Nile is 1:13,200.

Examination of Figure ---- (in which these changes in gradient are diagrammed) leads to the conclusion that the history of the Nile System has been complex. Ball discussed the theory that the low-gradient segment of the river between Juba and Khartoum had once been an extensive lake that had received all the drainage of the Blue and Victoria Niles, as well as of the Bahr el Ghazal and the Sobat. Thus, at an earlier time, the Nile that entered the Mediterranean along the periodically filled deeply excavated lower valley would have had its headwaters on the upper Atbara. A headward-growing tributary of that system eventually tapped the waters of Lake Sudd, which at its maximum extent had occupied all the land in the central Sudan now underlain by river alluvium, captured the Upper Nile, and integrated the Blue and Victoria Nile systems into the modern Nile. No date has been assigned to this event, but there is some indication that the suite of heavy minerals characteristic of a Blue Nile source did not appear in the sedimentary record of the lower Nile until middle Paleolithic time, possible as late as 50,000 years ago.

Ball calculated the total inflow to a lake of the size of ancient Lake Sudd (as determined from the area covered by river sediment still preserved in the basin) and concluded that the present rate of evaporation could have maintained a stable lake volume in the Sudd, even given the present discharges of the rivers that would have fed that lake.

Although arguments in its favor are persuasive, no concrete evidence supporting the Lake Sudd hypothesis has yet come to light.

MAJOR CONTROL POINTS ON THE NILE

Facility	Year Completed	Area (km ²)	Installed Capacity (km ³)	Maximum Loss (km ³)
Aswan Old Dam (Egypt, Main Nile)	1902	-	1.0	-
	1912	-	2.4	-
	1934	-	6.3	-
Aswan High Dam (Egypt, Main Nile)	1971	6000	165.0	16.0
Kashm el Girba Dam (Sudan, Atbara)	1964	150	1.2	.13
Jebel Auliya Dam (Sudan, White Nile)	1937	600	3.6	2.8
Sennar Dam (Sudan, Blue Nile)	1925	160	1.0	.30
Roseires Dam (Sudan, Blue Nile)	1966	290	3.0	.50

Source: Gischler, text footnote 5 p. 24; Guariso and others, text footnote 6, p. 379; Smith and other text footnote 7; Ibriham and others text footnote 12, p.51

THE GEOGRAPHICAL REVIEW

Schematic of the Nile River Works

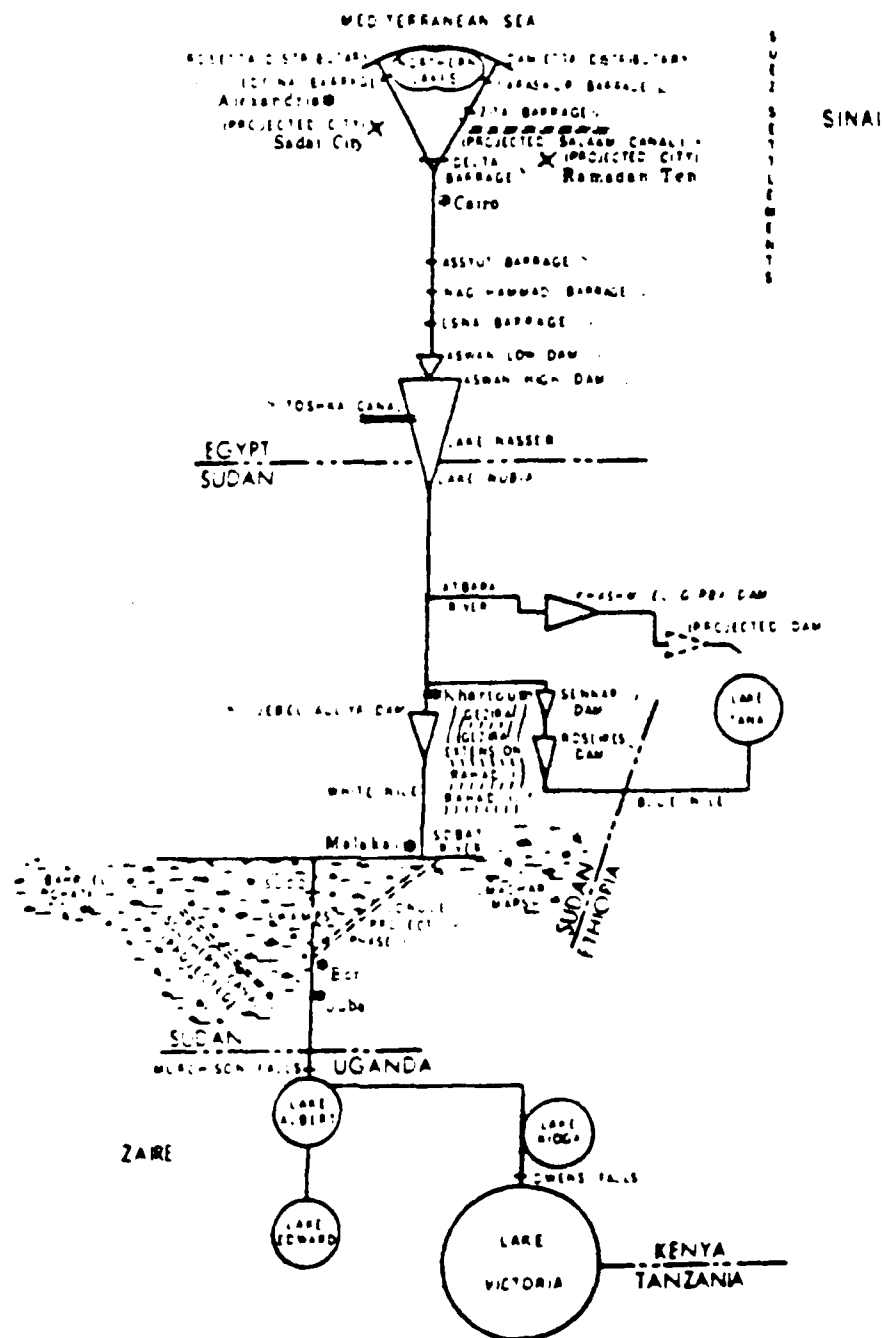


FIG. 1.—Schematic of the Nile River Works. Sources: Harold E. Morse, *The Nile* (London: Constable Publishers, revised, 1957), p. 262; Cischler, text footnote 5, p. 25; and John Waterbury, *The Nile Stops at Aswan* (American University, *Field Staff Reports*, Northeast Africa Series, Vol. 22, March 1957), p. 8.

ANNUAL DISCHARGE OF THE NILE

No. of years	Period	Mean in billion m ³	Std. deviation in billion m ³
30	1870-90	110.0	17.1
60	1900-59	84.5	13.5
90	1870-1959	92.6	19.8

Source: The High Aswan Dam (Beirut, Arab Institute for Research and Publishing, 1971).

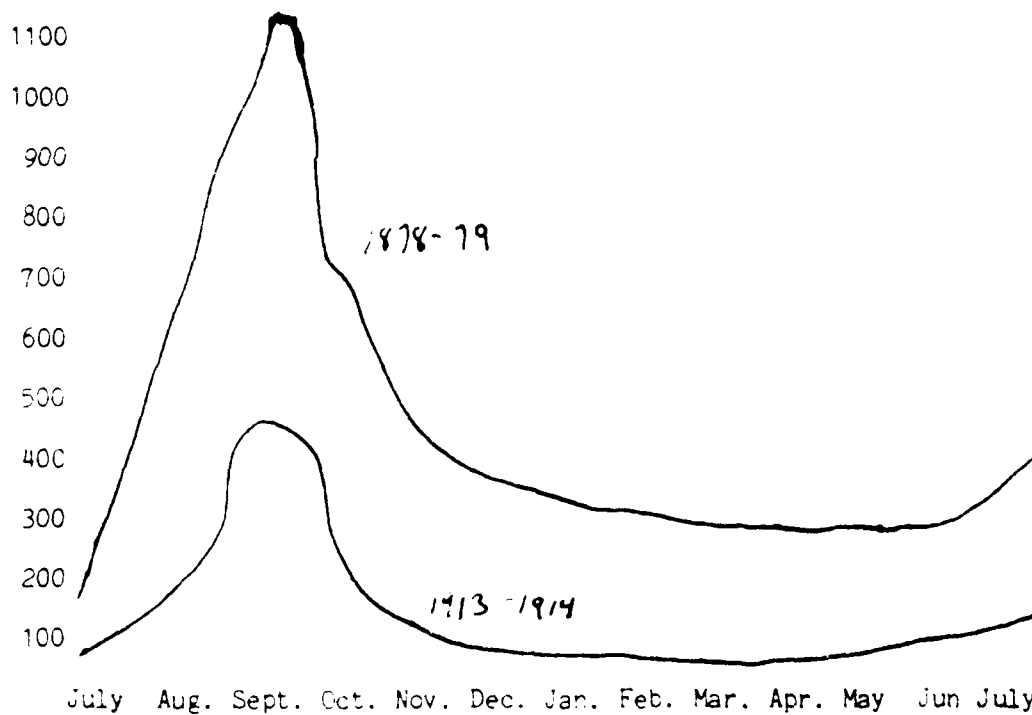
TIMELY WATER (FEBRUARY-JULY) AS MEASURED AT ASWAN (excluding High Dam, Roseires, and Khashm al Girba)

Natural Flow of the River	15.4 billion m ³
Stored at Lakes Victoria and Albert	5.3 billion m ³
Stored at Lake Tana	2.1 billion m ³
Stored at Sennar	1.0 billion m ³
Stored at Jebel Auliya (net of evaporation)	2.5 billion m ³
Stored at Aswan	5.2 billion m ³
Stored at Fourth Cataract	3.0 billion m ³
Subtotal	34.5 billion m³
Downstream Aswan; Wadi Rayyan	2-5 billion m ³
Grand Total	36.5-39.5 billion m³

CONTRIBUTION OF MAIN NILE SOURCES

	Tributary	12 Month Water Year	Flood Period
Ethiopian Sources	Blue Nile	59%	68%
	Sobat	14%	5%
	Atbara	13%	22%
Equatorial Sources	Behr el-Jebel	14%	5%

NILE DISCHARGE IN MAXIMUM AND MINIMUM HYDROLOGICAL YEARS AT ASWAN



Source: Michael Field, "Developing the Nile," World Cross (Jan.-Feb. 1973).

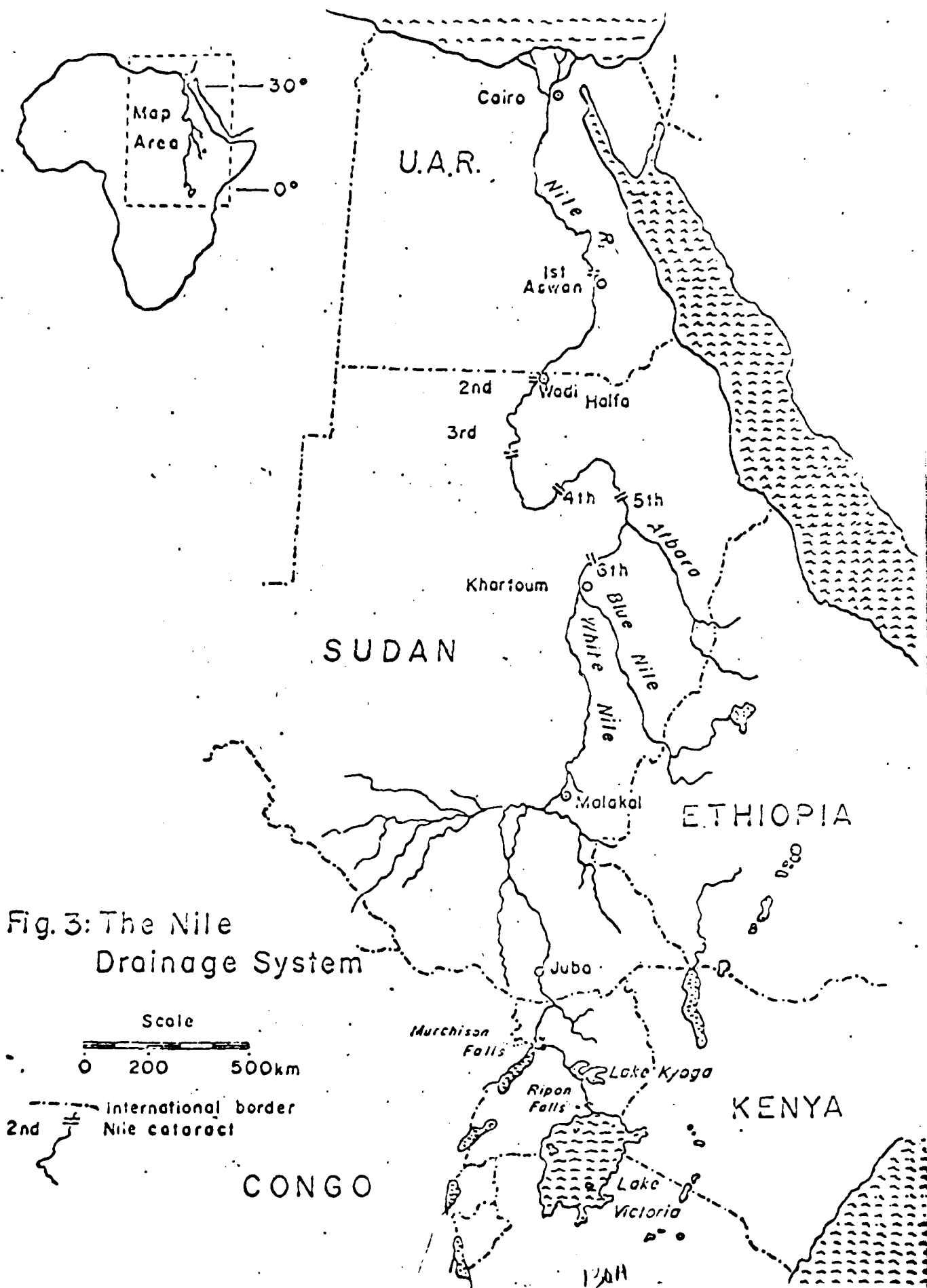


Fig. 3: The Nile Drainage System

HISTORY OF THE NILE

The Nile is an example of long term management of an extensive and complex water system through political control by a major user. Despite numerous riparians and water resource problems of the lower basin region, the Nile has escaped most of the conflict which has characterized other river systems.

Initial Cooperation, 1920-1945

The hydrological structure of the Nile River system is complex. The river's extensive catchment and drainage area spreads into the territories of nine riparians: Egypt, Sudan, Ethiopia, the Central African Republic, Tanzania, Zaire, Uganda, Rwanda, and Burundi. Egypt and the Sudan are historically the major users of the Nile waters. The Blue Nile originates in Lake Tana, Ethiopia. Uganda and Kenya cradle Lake Victoria from which the White Nile originates; Rwanda and Burundi are almost entirely located in the catchment area of the Kagera river, which feeds Lake Victoria; Tanzania is 33 percent in-basin with regard to the Kagera River; Uganda shares 10 percent of the Kagera basin; and Zaire and the Central African Republic send waters to the Bahr al-Ghazal, one of the Nile tributaries.

The rainfall which sustains the Nile has an extremely skewed distribution. Almost all rainfall originates in the Ethiopian plateau and the Lake District. The rainfall in the Sudan and Egypt is negligible.

Egypt has virtually exclusive usage of the Nile until the end of the 19th century. The reason for this particular uncommon pattern of river

usage is historical: from antiquity to modern times, Egypt has surpassed its neighbors in technological development and in political control of the waterway. The countries which share the upper reaches of the Nile have had alternative, largely unutilized water resources. During the British imperium in the 19th and 20th centuries over most of the territory drained by the Nile, Egypt maintained its dominant use of the river because the British prevented conflicts.

Even though Egypt had developed an extensive irrigation system, its use of the river for agricultural purposes was mainly basin irrigation, based on peak floods in late summer which were diverted by channels to basins of variable size. The diverted water was used for deep saturation of the soil.

Although perennial irrigation, in which smaller quantities of water are run onto the fields at regular intervals throughout the year, had been used to water small areas for thousands of years, it was not until the first quarter of the nineteenth century that a system of barrages and canals was started on the lower Nile so that this type of irrigation could be employed in most areas of the country. Perennial irrigation became necessary with the introduction of cotton which was a summer crop and therefore could not benefit fully from the annual floods.

The construction of barrages and canals accelerated rapidly after the British occupation of Egypt in 1882, culminating in the Aswan Dam which was completed in 1902 and later raised twice, once in 1912, which increased its storage capacity from 1,000 MCM to 2,500 MCM and again in 1933, which enabled it to store between 5,000 MCM and 6,000 MCM. Five other barrages were completed between 1901 and 1951: Assiut (1901), Zifta (1903), Isna (1909), Nag Hammadi (1930), and Edfina (1951).

Growing Egyptian needs eventually led to a clash of interest with the Sudan. Part of the disagreement was related to political-bureaucratic changes in the British colonial structure. The Anglo-Egyptian condominium over the Sudan was established in 1899, but British interests predominated from the beginning. Within the Foreign Office, proponents of Sudanese priorities competed with the promoters of Egyptian interests.

This conflict of interest within the British colonial establishment was further intensified by the relative shortage of cotton worldwide. Sir William Garstin's report of 1904 advocated irrigation of the Gezira for cotton growing. Four years later, a second report recommended the construction of a dam at Sennar on the Blue Nile that would irrigate 500,000 feddans in the Gezira south of Khartoum. (1 feddan = 0.42 hectare or 1.038 acres). This became known as the Gezira Cotton Scheme which was fully implemented in 1926 after the completion of the Sennar Dam. The Gezira Scheme together with its extensions are presently on line, and have brought over 2 million feddans under irrigation. It is the most important irrigation project in the Sudan and its completion remains a priority for the government.

In anticipation of increased water needs of both the Sudan and Egypt and out of concern over potential conflict, British engineers working for the Egyptian administration in the early years of the country developed plans for a comprehensive utilization of the Nile. The most elaborate plan proposed in 1920 by Murdoch Macdonald, required an ambitious cooperative effort to utilize the Nile water with special emphasis on upper Nile resources. Subsequently named the Century Storage Scheme, the plan envisaged a storage facility -- which is today Lake Mobutu on the Uganda-Sudanese border -- a large dam at Sennar to provide irrigation for

the Gezira Cotton Scheme, and another Sudanese dam at Jebel Auliya on the White Nile to conserve the summer flow of the Nile for Egyptian consumption. The only Egyptian based project within the Century Storage Scheme was the planned construction of a flood control barrage at Nag Hammadi.

This 1920 proposal aroused immediate opposition in Egypt. The publication of the plan coincided with the growing national movement in Egypt and was particularly criticized by the nationalist Wafd Party. One issue in the dispute was related to the storage and control facilities. Although the planned facilities were technically sound, the Egyptians were worried that all the major works were located outside their territory, thus beyond their direct control.

This reaction is characterized by Waterbury (1979) as the "Fashoda Complex," deriving from an 1898 incident that brought the French and British to the brink of hostilities because of a French expedition to secure the headwaters of the White Nile. The confrontation, ultimately settled by negotiation, dramatized Egypt's vulnerable dependence on the Nile, and fixed the attitude of Egyptian policy makers ever since. This sense of vulnerability motivated Egyptian criticism of water quotas under the Century Storage Scheme. Even a quota ratio of 1:8.2 suggested in a 1920 Egyptian government report, giving the Sudan 6,000 MCM and Egypt 50,000 MCM of usable discharge, was criticized in Egypt as inadequate to safeguard the country's needs.

The conflict was submitted to international mediation when, in 1920, the special Nile Project Commission was formed. The Commission, which included Indian, British, and American representatives, estimated Egyptian needs at 58,000 MCM with the rest going to the Sudan (although

the American representative, H.T. Crory, maintained that water should be allocated under a more equitable formula).

Despite its riparian dominance, Egypt agreed to international mediation because of pressure from Great Britain which still held a protectorate over Egypt; there was a desire to avoid a potentially messy clash with the Sudan, and Egypt needed a quick resolution to the issue because it desired a smooth and speedy transition to perennial irrigation which would end the increasing technical difficulties associated with basin irrigation.

Egypt was successful at asserting its position during the negotiations. The subsequent Nile Waters Agreement of May 7, 1929, reflected Egypt's dominant interests. The formula adopted for water allocation reaffirmed the primacy of the status quo as opposed to future developmental needs. The 1:12 ratio gave Sudan 4,000 MCM whereas Egypt received 48,000 MCM and usage rights to the entire flow of the Nile during the main January-July discharge.

The agreement only partly implemented the principle of optimal management of the Nile as envisaged in the Century Storage Scheme, with but a few sectional projects of the scheme carried out. They included the construction of the Sennar Dam in 1925 and the building of the Jebel Auliya Dam on the White Nile in 1937. The Sennar Dam had a storage capacity of 900,000 MCM and the Jebel Auliya Dam could hold 3,500 MCM. The large storage facility on what was then Lake Albert and the plans to drain the Sudd swamps were rejected. Egypt reserved the right of on-site inspections of the existing facilities as well as a veto power on any other construction which might have threatened its interests.

The 1929 agreement was not seriously challenged until the late 1940's owing largely to the gradual pace of Sudan's political develop-

ment, population growth and water needs, and to Egypt's political dominance and more rapidly expanding needs. The British did not want to be faced with an Egyptian-Sudanese confrontation in the midst of the twin crises of economic depression and the growth of fascism in Germany and Italy. The notion of the Unity of the Nile found common support among urban and intellectual elite groups in both Egypt and the Sudan, an ideological bond reinforced by mutual opposition to Britain's continued occupation of their countries.

The Period of Crisis 1945-1958

The ideological ties that bound both nations to the 1929 agreement began to erode after World War II. Changes in the political power structure of the Sudan resulting in a sharp rivalry between two political parties, the National Union Party (NUP) and the Umma Party (UP), and the demand for complete independence, caused the Unity ideology to lose its bonding power as a matrix for cooperation.

The debate over the Unity ideology was conducted against the background of a growing demand for full independence for the Sudan. The British, confronted by pressures to evacuate both the Sudan and Egypt, and with relations becoming increasingly strained and hostile in both, supported the rural based UP which was anti-Unity in its sentiments. The Umma, with its strength in the tribal south, the center, and the West, opposed the creation of a Greater Egypt which would combine Egypt and Northern Sudan. Sudanese opposition was also inspired by a growing awareness of the economic consequences of unity. As part of the price for unity, Egypt was requiring specified limits on future Sudanese cotton production. The Unity plan called for the transfer of Egyptians, mainly

peasants to the Sudan — a prospect that was considered a direct economic threat by the UP's rural constituency and evoked the spectre of violence should the Unity scheme be implemented.

Unity plans were made dormant by World War II, but after the 1952 Egyptian revolution the Egyptian government proceeded to carry out the Aswan High Dam project. New complications were added to the the Egyptian-Sudanese relationship. The storage capacity of the High Dam was projected 156,000 MCM of which some 30,000 MCM would be dead storage (i.e. unusable). The Dam was expected to expand cultivable land by 1.2 million feddans and to convert some 800,000 feddans of basin irrigation into perennial irrigation. This would permit multiple cropping and expand agricultural production, an important goal given Egypt's burgeoning population. The proposed Aswan project reopened debate on some old conflict issues and even added new dimensions to these.

The first issue to be contended was whether the Aswan High Dam would be a unilateral or cooperative venture. Although Egypt claimed that the High Dam would be carried out within the framework of established principles of bilateral cooperation, it was only in 1954 that the Sudanese was actually brought into the venture. In that year, Sudan challenged the Egyptian claim that the Aswan High Dam was the most efficient way of utilizing the Nile waters. They argued instead that the Century Storage Scheme, which was based on the utilization of the Upper Nile, constituted a more rational approach to water management.

The second dispute focused on the rationale for water sharing quotas. Egypt reiterated its historic position of "primary needs," based on the fact that the country had no alternative water resource and its estimated population of 22 million (with an annual growth rate of 2.5

percent) was totally dependent on the Nile. By contrast, the Egyptians claimed, the Sudan could utilize alternative water resources to expand its rain fed agriculture and had a small population of 8 million whose projected annual growth rate was only 1.6 percent. Arguing "primary needs," Egypt demanded 62,000 MCM of the estimated 70,000 MCM net discharge of the Nile; the remaining 8,000 MCM would go to the Sudan.

The Sudanese rejected the "primary needs" formula in favor of a more equitable sharing scheme which would take into account their upper riparian status. The Sudan claimed that in terms of its population, estimated at 11 million and its reluctance to rely on the vagaries of rain fed agriculture, the Sudan was entitled to 44,000 MCM of Nile discharge. In order to satisfy such an allocation Egypt would have had to relinquish a significant portion of the Nile quota acquired in the 1929 Agreement.

Egyptian-Sudanese negotiations, begun in September 1954, were soon broken off, in part because the positions of both parties were hardened by domestic nationalist politics (especially in the Sudan which was fighting for the independence it won in 1956) and by the concern of the Sudanese government that acquiescence to Egyptian demands would intensify unrest in the southern provinces which were in the incipient stages of a secessionist movement that remains active today.

The crisis deteriorated into a military confrontation in 1958 when Egypt dispatched an unsuccessful expedition to reclaim some disputed border territory. Relations between the two countries reached a nadir in 1959 when the Sudanese abrogated the 1929 Agreement by unilaterally raising the height of the Sennar dam.

Throughout the conflict, Britain, owing to its dispute with President Nasser over his demand for evacuation of the Canal Zone, supported the Sudanese position and the Sudan reciprocated after the 1956

Suez war by endorsing the Eisenhower doctrine which promised U.S. aid to any Middle Eastern country threatened by Communism. Egypt, determined to proceed with the Aswan project, turned to the U.S. for financing, but to no avail. In frustration Nasser turned to the Soviet Union which seized the opportunity to thrust itself into the heartland of the Middle East and agreed to provide the necessary financial and technical aid, directly adding a cold war dimension to the already international character of the Nile dispute.

The Period of Cooperation 1958 - 1983

The combination of Soviet support and a new more sympathetic military regime in Khartoum which seized power in a coup d'etat in 1958, caused Egypt to adopt a more conciliatory posture. In response to new conditions, the Sudanese and Egyptian governments moved speedily into negotiations once more. On Nov. 8, 1959 the Agreement for the Full Utilization of the Nile Waters was signed.

The 1959 Agreement reflected a more equitable approach to water sharing. The Sudanese allocation was raised to 18,500 MCM while Egypt's quota was 55,500 MCM constituting a 1:3 ratio. Any future increases in the yield of the river would be allocated on the basis of parity. The Sudan was also to receive compensation for the displacement of the Sudanese Nubians resulting from the construction of the Aswan High Dam. The implementation and supervision of the Agreement was vested in a Permanent Joint Technical Commission which was empowered to adjudicate future conflicts between the two countries. The Agreement on shared utilization and future development of the Nile stands as a model of what can be

achieved in the way of settlement by neighbors with a will to end conflict.

Despite technical arguments that the Century Storage Scheme was probably a superior plan, the Aswan High Dam was from its inception, imbued with great symbolic value. Its monumental proportions were made to symbolize Egypt's new revolution and to provide an achievement that would generate great national pride and unity. These political and symbolic considerations were clearly on the minds of the Egyptians who negotiated the Agreement.

The powerful nationalist component in the Agreement is reflected in its bilateral nature. At the time of the Agreement most of the African Nile riparians were still British colonies. Britain's efforts to represent its colonies during the negotiations were rebuffed by Egypt, still smarting over the 1956 Suez campaign, as yet another British attempt to interfere in the region's affairs.

In approaching the negotiations, Egypt and the Sudan were agreed in their estimate that the consumption needs of all other riparians combined would amount to between 1-2,000 MCM annually, or about 1-2 percent of the Nile's flow below Aswan. With such marginal needs established in the negotiations, Egypt successfully rejected a British proposal to create an International Water Authority, in which all the riparians would be represented, for regulating distribution of Nile waters. Although all the African riparians gained independence in the subsequent two decades, they did not formally adhere to the Agreement. Ethiopia, which commands the hydrostrategic headwaters of the Blue Nile, served notice in 1957 it would exercise its water rights unilaterally, and subsequently has received limited Soviet technical assistance. But with so little technical, financial, or political capacity of its own to undertake projects

which would have a significant impact on Egypt's usage. Ethiopia's posture, even under a Marxist regime, is not considered threatening. Uganda and Kenya declared pro forma that they reserved the right to determine the future disposition of the headwaters of the Nile. However, since their needs are well satisfied by alternative sources, and they too lack the means for making significant changes, their declaration has not conjured up harrowing spectres in Cairo. The technical aspects of the Agreement focus on the Aswan High Dam. Construction was begun in 1960 and completed in 1971, but the entire project did not become fully operational until 1975.

The Aswan High Dam which is one of the largest constructions of its kind, was expected to fulfill several objectives, the most salient are: 1) to protect Egyptian agriculture from both annual and periodic variations in the flow of the Nile, 2) to extend multiple cropping along the Nile Valley, 3) to expand the total area of cultivated land by 1.2 million feddans 4) to convert 800,000 feddans from basin to perennial irrigation, 5) to generate annually 10 billion kwh of electricity.

Several problems emerged in the process of implementation. The most widely discussed issue has been on the ecological impact of the project, an issue debated both in Egypt and abroad, on both technical and political levels. Even before the Aswan Dam was completed, there was widespread concern that it would create a number of problems: 1) massive losses of water through surface evaporation of Lake Nasser (the storage facility of the Dam); 2) trapping of silt in the lake would deprive downstream users of soil nutrients, thus necessitating widespread use of fertilizers; 3) waterlogging in soil channels leading to the rise of salinity and degradation of water; 4. erosion of the coastal line and

incursion of seawater into the Delta; 5) spread of schistosomiasis (bilharziasis) a highly dangerous parasitic disease transmitted by snails. 6) proliferation of the "killer mosquitos" from the Sudan that spread malaria.

Some of these problems were less serious than anticipated and some were alleviated by using new technology. However, these observations represent a trend supported by current research. Definitive conclusions must await confirmation by long term research. It can be said that on evidence to date, on the whole, the Aswan High Dam has been a relatively successful undertaking.

However, serious problems exist. Some of the problems created are not related to the construction of the Dam per se but rather to government policies on water subsidies. By maintaining the cost of water to Egyptian farmers at a fixed minimal price, the government has encouraged over irrigation which produces a rise in the underground water table and degradation of the soil. Much needed drainage projects which would protect against degradation, have given way to irrigation and land reclamation projects. Consequently, it is estimated that the soil in 35 percent of the cultivated land suffers from salinity, and 90 percent from waterlogging. Improvement in drainage, some experts believe, could turn the situation around and lead to a 20 to 30 percent increase in overall productivity.

The impact of the Aswan High Dam on Egyptian agriculture is perhaps the most significant dimension of the project. The record shows that the major goal of dramatic improvement in Egyptian agriculture has not yet been attained.

Achievement of this goal is central to Egyptian planning because agricultural production accounts for about 30 percent of the GNP and 60

percent of export income. About 60 percent of the Egyptian population of 43.3 million is employed in agriculture. Furthermore, Egypt's population growth rate is 1 million net every ten months. However, the amount of land the government hoped to reclaim and add to the 6 million feddans under cultivation has fallen far short of expectations. Official figures have varied greatly, and are unreliable, tending to mix marginal with productive land in the statistics, which are of questionable accuracy. Nonetheless, a reasonable figure of about 350,000 to 400,000 feddans of land with submarginal to marginal productivity have been reclaimed -- as contrasted with early claims of 1.2 million feddans. Clearly, investment in submarginal lands failed to yield proportional returns in productivity. Owing in part to considerations of labor intensity, effort and resources were put into land reclamation rather than into development of those agricultural technologies that would have increased productivity per feddan. Although Egypt has achieved impressive yields for some crops such as cotton, wheat, maize and rice, total productivity cannot keep pace with local consumption. The situation would be exponentially worse without the Aswan High Dam. In any event, any policies adopted which trade off higher production for jobs or loss of land ownership carry the highest risk of political upheaval. Such policies must be prepared for carefully and introduced only gradually.

The impact of the 1959 Agreement on the Sudanese economy has been largely positive. In the early 1970's the total available agricultural land pool in the Sudan was estimated at 291.788 million feddans, including some 54.4 million feddans of pasturage and 212.235 million feddans of forests. Under the Agreement some 3.218 million feddans were irrigated by 1970 and another 21.835 million feddans could be cate-

alized as rainfed agriculture. Prior to the end of the decade of the 1960s the Sudanese agriculture and nomadic economy placed no serious strains on water resources. In fact, the only substantial irrigation agriculture centered on the Gezira Cotton Scheme. In the first ten year economic development plan initiated in 1961, the major agricultural goal was a transition from subsistence to cash crop agriculture (GNP diversification and technical modernization constituted the other two principal objectives). Wheat and sugar were marked for special attention in order to increase import substitutions.

To achieve these goals a number of irrigation schemes were planned: (1) the Roseires Dam on the Blue Nile; (2) the Khashm/al-Girba Dam on the Abana; (3) the Menagil Extension Project designed to boost the Cotton Gezira Scheme by 290,000 feddans. The Roseires Dam was completed in 1966.

On achieving power through a coup d'etat in 1969, General Numeiry reoriented the government's economic policy toward industrial development. The failure of this policy produced a reversion to the primacy of agricultural development in the 1977-83 five year plan. The new agriculture policy drew on proposals developed by the Arab Fund for Social and Economic Development (AFSED). The AFSED ten year plan published in 1974 included an ambitious 20 year scheme to increase irrigated agriculture by 9 million feddans and the rainfed farming to 22 million feddans. The plan envisaged huge increases in such crops as wheat, sugar and maize. Although subsequent developments revealed that the plan was overly ambitious, increases were achieved in the production of some crops such as wheat and sugar.

TECHNICAL ASPECTS OF THE NILE RIVER

There are presently six major dams and a series of eight barrages managing the Nile water. Table XX shows the compounded losses by evaporation and seepage from each, the greatest one being from the Aswan Dam. Although losses from the Aswan reservoir were expected to be 10,000 MCM (the figure upon which the 1959 Agreement was based) recent estimates are approximately 13-14,000 MCM. This figure might still be conservative, since the estimation assumes that the Sudan has been withdrawing its full 18,500 MCM quota allotted in the 1959 Agreement. According to Whittington, however, the Aswan has had an excess filling in recent years largely due to failure by the Sudan to withdraw its maximum quota. The surplus has been used by Egypt.

The 84,000 MCM flow figure for the Nile excludes a series of high floods which makes the agreement more advantageous to Egypt. Any excess water, i.e. any amount above the Sudan's quota, passes into Egyptian hands. According to many reports, Egypt has been using all of its allocated water and only minimal amounts have reached the Mediterranean Sea in recent years.

Water Quality

As a whole, present water quality in the Nile is good in terms of salinity. The water shows 220 ppm as it leaves Aswan. This figure increases to about 300 ppm at Cairo, a change attributed to the effects of both agriculture and the High Dam.

Salinity measurements available for sources of the river include 80 ppm for Lake Victoria, 670 ppm for Lake Edward (formerly Lake Idi Amin), 590 ppm for Lake Mobutu and at Khartoum, 130 ppm for the Blue Nile and 140 ppm for the White Nile.

There is concern that water quality might be a problem along the Nile before quantity really becomes an issue. Both Egypt and the Sudan are undergoing agricultural expansion and have plans for rapid increase in the next decade. Both are heavily dependent upon fertilizers and pesticides and Egypt's levels of application are higher than both those of the U.S. and Britain. Upstream riparians also plan growth in agriculture that might add to the decrease in quality. Salinity in the Upper Nile is increasing due to several factors: existing and future projects, mainly agricultural expansion; increased evaporation due to heightening of the Roseires Dam; increased evaporation at control points of the second phase of the Jonglei project and the Baro reservoir in the Machar Marsh project, increased man-made storage in the Sudd, Lake Kioga and Lake Mobutu; and decrease of filtering of the suspended solids in the White Nile's water from the Sudd and the Machar Marsh.

Due to the present low level of industrialization of the riparian states, there are not any serious sources of pollution. There is some localized pollution due to sewage where population is high, mainly in the Delta and Jinja. The fact that pollution is generally negligible or absent is, however, due to the vast dilution allowed by the river. Cities with waterborne sewage disposal such as Cairo and Khartoum re-use their effluent, after partial treatment, for irrigation.

There is a growing concern that agreements among the riparians for water management must include considerations of the health effects of any project. Although salinity is the main concern due to the possible

constraints it can impose on agriculture quality must be considered in terms of waterborne diseases as well, most notably schistosomiasis. Many of the endemic diseases in Egypt and the Sudan are waterborne and have been widely increased and spread through perennial irrigation. This would be a main concern should exportation of Nile waters to the Sinai or Israel be seriously considered.

Water Consumption and Water Demand

Egypt's population was 43.3 million in 1981 with an annual rate of increase of 2.5 percent. Increasing food production, i.e. increasing agricultural production, to meet the needs of the expanding population is a primary concern of the government. Official strategies include improvement of land and water use, increase in yields and additions of at least 150,000 acres/yr of agricultural land until the year 2000 in order to keep the already low (0.17 acres) per capita share from decreasing further. Productivity is already high at 1.7 crops/year/feddan, and over 99.5 percent of farmland is irrigated. Almost 99 percent of Egypt's population lives in the Nile Valley and the Delta, three-fifths of them engaged in agriculture. Only 3.5 percent of the country is cultivated and there are plans to increase this figure to 5 percent by the year 2000.

Lacking water resources other than the Nile, Egypt has turned to recycling municipal, industrial and agricultural water, and groundwater withdrawal in the Delta. These add respectively 4500 MCM (from recycling) and 500 MCM (from groundwater) to its water supply (see Table XX). Some reports consider the possibility of these figures being optimistically raised to 12,000 MCM and 1,000 MCM respectively by 1990.

According to Whittington, there is a major uncertainty in the extent of re-use of agricultural water. He considers that part of the 15-20,000 MCM of agricultural drainage water currently discharged into the Mediterranean and the northern lakes may be suitable for reuse.

Estimates of Egypt's water supply and demand do not seem accurate. In 1978 Cairo alone, with one-quarter of Egypt's population, consumed 1003 MCM. This contrasts sharply with estimates by the Egyptian Ministry of Irrigation, USAID and U.S. Dept. of Agriculture, which calculated all of Egypt's domestic and industrial needs for the mid 1970s to be about 1000 MCM. Still, some sources are using 1000 MCM as the domestic/industrial estimated demand for 1986-1990. Waterbury classifies estimates as "optimistic," "cautious," and "pessimistic" with domestic/industrial demand varying from 1000 MCM to 4000 MCM to 6500 MCM respectively. His figures for total supply and total demand yield a surplus of 14,900 MCM for the optimistic category, and deficits of 7700 MCM and 14,100 MCM for the cautious and pessimistic categories. According to Whittington, current availability ranges from a deficit of 300 MCM to a surplus of 5300 MCM.

However, different sources seem to agree that reclamation of 3 million feddans of desert land targeted for 1996 might result in a major water shortage. Estimation of the potential shortage is especially difficult due to uncertainty about many aspects of agricultural water usage. Both overwatering and underwatering are claimed, but neither can be confirmed due to lack of organized data and lack of information relating water requirements to soil drainage. The latter might explain different views about requirements, as well as overall efficiency and performance of the irrigation system. Agriculture accounts for 95 per-

cent of water use in Egypt. Estimates by the Ministry of Irrigation for water use are almost 8,000 m³ per feddan with the possibility of a decrease of 600 m³/feddan in clay soils. The use of sprinkler systems on sandy soils reduces the requirement to 5,200 m³/feddan. Drip systems (now in experimental stages in Egypt) decrease this need to approximately 3000 m³/feddan. (However, use of saline water would increase such estimates due to flushing requirements.)

It is important to remember that deficit is a function of demand and supply. Demand in both Egypt and Sudan needs to be viewed in the context of development strategies. The demand for agricultural water in Egypt could theoretically be decreased by more than 50 percent with the implementation of new technologies and a serious conservation program. This could have important implications on estimations of demand.

As regards the Sudan, most estimates reflect hopes of making the country into the "world's breadbasket." However, recent studies by Dutch consultants (ILACO) have lowered such hopes. Serious problems relating to drainage and soil led the consultants to recommend abandonment of plans for large-scale intensive mechanized farming. The hope now is to settle the local population on small parcels of land. This change of direction in policy and choice of technology will affect the figures for demand.

The Sudan's total area is 2,505,813 sq km, 49 percent of which is suitable for agriculture. Of this, 0.54 percent was irrigated in 1970. The amount of irrigated land is estimated to increase to 0.7 percent by 1985. The Sudan's water demand in the mid 1970s was 1919 MCM. This demand is expected to be about 3820 MCM by 1990, indicating a deficit of about 1377 MCM.

Water-Management Schemes on the Nile

The Nile has been the site of some of the most ambitious and most successful schemes of water-resource management in history. In the Pharaonic era, Egyptian hydraulic engineers had constructed an elaborate system of irrigation works in the part of the lower Nile basin where the river flows on alluvium it has deposited. Pharaonic water-management facilities included flood-plain-margin basins for retention of excess water that arrived with the annual flood, a complex series of irrigation distributaries that even included special low-elevation drainage ditches to permit the final few percent of the retained flood waters to drain through the soil in the irrigated lands, carrying off the accumulated salts in the soils, and a carefully engineered canal, the Bahr Yusuf, that allowed Nile water at the peak of the annual flood to flow over the low divide separating the river from the closed depression of the Fayum, 60 km west of the Nile Valley. This water was used to irrigate a major agricultural development in that valley. The Romans who entered Egypt were also accomplished hydraulic engineers, but they failed to appreciate the significance either of the low-elevation drainage ditches or the Bahr Yusuf; a major Roman town built on the shores of the lake in the Fayum (lake Moeris in antiquity; Birket Qarum today) was left high and dry by evaporative losses from the lake shortly after it was constructed, since the Roman engineers failed to maintain the Bahr Yusuf as a forum that would provide annual inflow to the lake sufficient to balance the losses to evaporation.

In the latter years of the 19th century, when Britain controlled much of the terrain drained by the Nile, water-control schemes of varying levels of complexity were constructed on parts of the Nile, primarily as

devices to retain the high discharge of the annual flood and parcel it out to irrigation developments over a longer portion of the year than Pharaonic basin irrigation had allowed. After nine years of planning, construction on the Aswan High Dam began in 1960. An emergency spillway (the Tushka, or Sadat, Canal) to carry flow from excessive Nile floods into interior depressions of the Western Desert was conceived in 1970 and completed in 1980, after its originally planned size was reduced by half.

Around 1981, serious debate about the impact of the High Dam emerged openly in Egypt. The High Dam's ecological and social ramifications transcend Egypt's borders and include such negative factors as the spread of schistosomiasis, strain on economic resources (such as degradation of soil followed by intensive fertilizer application which is very expensive), and the High Dam's effect on other ecosystems (such as the degradation of physical geography and aquatic life in the Mediterranean). Most aspects of the Aswan High Dam's impact — positive and negative — have been well documented. They need to be screened from international and domestic politics before accurate conclusions can be drawn on the real influence of the Dam on the region and its people.

At the present time construction is proceeding on the first phase of the Jonglei Canal, a waterway that will carry discharge from the upper White Nile around the Sudd, avoiding the substantial losses to evaporation that occur there today. It is expected to yield 4700 MCM/yr at Malakal, decreasing to 3800 MCM/year at Aswan. The canal is expected to provide a navigable waterway, allow irrigation of the adjacent land, and settle the Nilotic tribes. Originally planned to be 280 km in length, it is now being extended to 360 km. Since the Sudd had an important effect

in decreasing salinity of the White Nile, an increase in downstream salinity should be expected.

The agreement reached between Egypt and the Sudan in 1959 regarding future development of the entire Nile system is considered a historic example of the quality of cooperation possible between riparian neighbors. It is significant that no other riparian country was involved in that agreement, and that the Sudan was very much under the political and cultural dominance of its far stronger neighbor to the north.

Today, although a basin-wide approach seems to be part of Egyptian planning, Egypt continues largely to ignore riparians other than the Sudan. However, management depends on the policies and activities of upstream countries. For example, Tanzania's and Kenya's use of Lake Victoria for irrigation could reduce available water for both Sudan and Egypt. The Aswan High Dam was expected to obviate the need for international management and cooperation. However, the High Dam's storage capacity is proving insufficient to accomplish all expected functions. Most, if not all, efficient solutions to Egypt's water problems involve storage outside its borders, the main project proposals being in Lake Mobutu (Uganda and Zaire), Lake Victoria (Uganda, Kenya and Tanzania), and Lake Tana (Ethiopia).

Egypt, vulnerable both in terms of quality and quantity of the Nile's waters, has one overriding concern: until recently, Cairo's control of the Nile through power and megaprojects had been unchallenged. Now, owing to a proliferation of small upstream projects, Egypt faces the possibility that its technological dominance among the riparians and its controlling political power will decline while its vulnerability and dependence as a downstream user increase.

There are a number of Upper Nile projects planned by the Sudan and Egypt which would be shared equally under the terms of the 1959 Agreement. They would add about 18,000 MCM to the Aswan reservoir by 1990, half of which would go to Egypt provided the 1959 Agreement remains in effect, and provided that other riparian states such as Ethiopia and Uganda do not object to or demand to share the benefits of such projects.

UPPER NILE WATER PROJECTS

Project	Installation Operation	Period	Water Savings at Aswan (km ³)*
Jonglei Phase I (Sudan)	Jonglei Canal Bor Extension Channelization of part of Bahr el Gebel	1977-1985	3.8
Jonglei Phase II	Lake Albert Dam Widening of Jonglei Canal Regulation of Lake Victoria for storage New regulation pattern for barrage on Lake Kioga	1985-1990s	3.2
Machar Marsh (Sudan & Ethiopia)	Baro-Gambeilla Dam Khor Mauhar Embankment Machar Marsh Canal	mid 1990s	4.0
Bahr el Ghazal (Sudan)	Northern Bahr el Arab Canal Jur River tributary Bouchery and Sewi reservoirs Southern canal (Tonj to Bahr el Gebel)	mid 1990s	7.0
Total			18.0

Sources: Ibrahim, text footnote 11; Fahmy and El shibini, text footnote 12; Ibrahim and others, text footnote 12, Mageed, text footnote 12; and Ibrahim, text footnote 30.

* To be divided equally between Egypt and the Sudan.

PROSPECT FOR COOPERATION AND CONFLICT

In spite of some of its shortcomings the 1959 Nile Agreement has proven to be a successful formula for the management of the Nile water system. It is also one of the very few international river agreements whose provisions include disproportionate ratios of quotas, and at the same time cooperative development, and mechanisms for the peaceful resolution of conflicts. The Agreement works mainly because of the degree of control exercised by Egypt and because of perceived political and security advantages in pursuing a pro-Egyptian policy by the current Sudanese regime. However, prospects for continued cooperation will depend on whether two impending challenges to the status quo are solved.

The most ominous problem is created by the population explosion in Egypt. If the current annual 2.5 percent growth rate is not stemmed, the estimated population of Egypt will reach 50 million by the end of the 1980s and balloon to over 70 million by the year 2000. At present, despite some official effort, the government is not contemplating the drastic measures which would be required to stem the growth rate significantly. Nor is the pace of improvement in the overall standard of living, which would slow birth rates, likely to increase rapidly or substantially. Consequently, the prospects are gloomy; the situation will have to get worse (as it inexorably will) before it gets better. Unless the population growth rate begins to decline and sustains a downward slope, or Egypt gives up its goal of providing most of its own agricultural requirements, and develops instead a large scale export economy importing most of its food (a highly improbable likelihood but

discussed nonetheless), then Egypt faces a very real prospect of water shortage by the end of the century.

A variety of projects and plans for enabling agricultural production to stay abreast of population growth are under way in Egypt. These activities include the use of new varieties of seed, improved cropping patterns, pest control, increased chemical fertilization and water conservation schemes. Better on-farm water management through the employment of sprinklers, drip irrigation, recycling irrigation water and the leveling of fields could yield water savings which some experts estimate could reach 10,000 MCM, surpassing the almost 8,000 MCM created by the Aswan High Dam.

In order to achieve self sufficiency in food by the end of the century, Egypt would have to cultivate at least 22 million feddans of arable land. It is improbable that such a goal could be achieved. Not only is it doubtful that Egypt has that much land that is reclaimable but the present cost in relation to benefit of bringing additional land into cultivation is very expensive.

A brewing conflict between the demands on Nile water resources for hydroelectric power by the Egyptian industrial sector and those for irrigation and land reclamation by the agricultural sector complicate efforts to project the country's future water needs. Should the industrial sector's needs prevail there will be a decrease in water demands, while the opposite will be true if the agricultural sector's interests dominate. Either way, difficult and potentially destabilizing political decisions would be involved. Hence, the present temporizing and attempts at compromise by the government.

A few innovative plans, such as one promoted by the late President Sadat, which would have combined industrial and agricultural development,

have never progressed beyond the argument stage. One in particular would have utilized the Nubian aquifer estimated to contain up to 234,000 MCM of water (such high conjectures are probably overly optimistic) to establish several urban and agricultural centers in the eastern and western deserts. But disagreements among experts over the political, economic and technical feasibility of such schemes, not to mention social dislocation, have defeated them.

In the Sudan, owing to the production of both irrigated and rainfed agriculture, and to a relatively small population, future water needs are considerably more modest than those projected for Egypt. In the 1970s the Sudan's standing as an agricultural producer improved significantly, in part because of greater demands for farm produce created by ambitious development plans among the Gulf states and in part because Egypt needed more food to feed its growing population.

In response, the Sudan increased cash crop cultivation, especially sugar cane which consumes water at a high rate. Industrial and domestic consumption of water will not be a major factor of depletion in the foreseeable future. The total Sudanese population is roughly 14.7 million - 10.5 million rural dwellers, 2.6 million urbanites, and 1.6 million nomads. However, the estimated water need for agricultural irrigation is 27,151 MCM. The projected total water needs for the Sudan in 1985-86 are 32,606 MCM which would result in a 9,706 MCM deficit.

The relatively low quotas set for the Sudan coupled with the growing needs of Egypt may set the two major riparians on a collision course. Such a development may be averted by carrying out projects included in the Original Century Storage Scheme. One possible venture is the 1974 decision of Egypt and the Sudan to consider the construction of the

Jonglei Canal around the Sudd. At the Sudd swamps located north of Juba in the Sudan, the White Nile (Bahr el-Jebel) loses half its annual discharge of about 28,000 MCM through evaporation. The project took some time to get underway because of concern over the displacement of some 700,000 people who live in the area and because the continuing civil war in the south. The project is now moving forward, but a completion date is difficult to schedule because of disruptions stemming from political strife which have resulted in work stoppages.

The displacement of native populations as a result of major irrigation schemes in the region has been an ongoing concern. The follow up studies on some 60,000 Nubians who were displaced as a result of the construction of the Aswan High Dam indicate a reasonable adjustment following initial stress and social disintegration. Long term sociological implications of irrigation-related displacement are currently being studied. Regardless of the result, any irrigation scheme which involves relocation of large populations presents difficult political choices to government elites in the region.

Coercive usage of water is common with regard to navigational waterways in the Middle East and elsewhere. Denying usage to downstream users has not been practiced often but cannot be ruled out altogether as a very low probability prospect in the distant future. None of the upper riparian actors possesses, or is likely to acquire in the foreseeable future either the necessary military or political power to exercise coercion even if the motivation were to exist.

The stability and friendliness of the Sudan on the one hand, and Egypt's dominance on the other, will continue to be the basic determinants of the situation. Thus, the political affinity between the two countries is of paramount importance in ongoing cooperation for the

management of the Nile's waters. Any change or threat in the political system of the Sudan will always bring a defensive response from Cairo.

The Sudan has a recent history of political instability as evidenced by a string of attempted coups in the mid 1970s, the chronic secessionist strife in the South, and the continuing anti-Sudanese machinations of Libya culminating in the Libyan air attack on Omdurman on March 18 of this year. Added to such political and military risks is the ingredient of militant Islam, to which the Sudan is as susceptible as any other Muslim state in the region and perhaps somewhat more vulnerable owing to weakness in the present regime. Out of obvious self-interest, Egypt is doing what it can, including encouraging stepped up U.S. economic and military aid to Khartoum, to prop up General Numeiry. Numeiry's public piety has increased conspicuously in the last few years.

Should Egypt's rate of population growth continue unmitigated until it reaches the predicted crisis proportions towards the end of the century, the resultant problems will certainly compound any existing processes of political disintegration. Egypt, in such a case, will attempt to intensify its political control over the Nile, and will be more inclined to resort to military responses to any manipulations of the river's resources that Cairo views as threatening.

INTERNATIONAL LEGAL ASPECTS
OF MIDDLE EASTERN RIVERS

INTERNATIONAL LEGAL ASPECTS OF MIDDLE EASTERN RIVERS

The international legal system is generally characterized by a highly developed body of sophisticated legal substantive doctrine coupled with a primitive set of legal institutions. As a result, very elaborate legal analyses can be developed which have only limited chance of affecting the problem at hand. The law dealing with international rivers is typical of this situation. This analysis will consider both the relevant international legal doctrine and the available international legal institutions.

Analyses of the role of international law in settling the conflicts over, or reinforcing the cooperation regarding, the six river systems of this study will be organized around the basic kinds of competing uses for fresh water found in the region. The chapter focuses on paradigmatic river systems rather than on a sequential (and repetitive) study of each river system. The Jordan River will be the paradigm for consumptive uses of water, the Shatt al-Arab for non-consumptive uses. The other river systems will be discussed to the extent that they present different legal issues.

The two paradigmatic river systems have been the center of controversy throughout most of the Twentieth Century. They illustrate both the potential for conflict over water within the region, and the possible uses of legal processes in resolving or preventing such conflicts. Yet the conflicts over the Jordan and the Shatt al-Arab have been centered neither on legal right nor on water. The controversies over water have occurred in the context of conflicts over a broad range of issues. Water has ~~has~~ sometimes been more of a pretext than the real cause of dispute.

Legal analysis of the conflicts over fresh water in these arenas must therefore take into account issues (and their probable outcomes) which have little or no direct bearing on water as such.

The Nature of International Law

Any legal system exists through a body of doctrine which provides answers for the questions with which the legal system concerns itself, and a set of institutions to apply that doctrine to such conflict situations as come to the attention of the system. International law combines a fairly developed and sophisticated body of legal doctrine with an almost rudimentary set of institutions. The disjunction between doctrine and institution is a longstanding feature of international law; there has been a slow but steady evolution in the 20th century toward more developed international legal institutions.

Sources of International Law: The ultimate source of international law is the consent of the nations that participate in the system. Derived from this premise is a set of sources which are most succinctly set forth in Art. 38 of the Statute of the International Court of Justice (effective 1945). The four sources are: international agreements, international custom, general principles of law recognized by "civilized nations," and (as a secondary source) authoritative opinion. Since the order of these sources reflects the reliability of the source as reflecting the consent of the affected nations, this sequence also established the hierarchy of sources. In case of inconsistency, international agreements control over any other source. The list of sources in the Statute is generally

accepted both as a complete list and as setting forth the interrelationship among the sources.

The role and scope of agreements in international law is doctrinally well developed. There treaty on treaties – the Vienna Convention on the Law of Treaties (1969). There are significant differences between agreements of universal scope, and those which are multilateral or bilateral. These difference affect the creation, implementation, and termination of the agreement. "Universal" agreements are often held to express or create a general custom binding even on non-signatories. It has been asserted that some rules contained in universal treaties are so fundamental that even states that strenuously opposed a treaty are bound by it (see jus cogens below).

There is extensive state practice and practicing literature on custom as a source of international law. Two elements are required: a continuing practice, and the sense that the practice is a result of a legal obligation. Since the continuing practice is relatively easy to prove, most controversy has focused on the second element, a sense of legal obligation (the opinio juris). It is often nearly impossible to prove whether the practice reflects an opinio juris, and whether all concerned states have accepted the custom as binding.

Where a rule is considered so fundamental that it must bind all states, all states are bound even if they have refused to accept the rule. This is termed a jus cogens, a concept which grew directly out of the experience of World War II. It is obviously difficult to reconcile the concept of a jus cogens with the theory of consent as the ultimate source of international law, but the concept has gained general acceptance.

A quasi-legislative process is emerging in the treatment of Resolutions of the U.N. General Assembly. Such Resolutions normally are recommendations with no binding effect even within the U.N., but such Resolutions create customary rules since the resolutions are useful to prove the consent (or lack thereof) of a particular state to an emerging custom, or to document the elusive opinio juris.

The claim that a particular principle of national legal systems is so general as to be a rule of international law has never been widely used in practice, but it has some utility for settling local controversies. Since legal systems within a region often are fairly homogeneous, a regional principle of law, or a local one shared only by the actual participants to the controversy, may be applied to resolve a controversy. Sometimes this is done under the guise of regional or local custom.

The opinions of courts, of other judicial decisionmakers, and of leading scholars, are treated in precisely the same manner in international law: as a secondary source of law. These opinions are not a direct source of authority, but can be used to prove the necessary elements of the primary sources (agreements, custom, and general principles). There is no concept of binding judicial precedent. Precedent in international law is made by the executive branches of governments, not by courts. Opinions — both judicial and scholarly — carry weight as evidence of opinio juris, or lack thereof. As such, opinions can play a decisive role in the formation of international customary law. Opinions can also be decisive as to whether a particular rule is so fundamental as to be a ius cogens, or whether a principle of national legal systems is sufficiently general to be a source of international law.

The international legal system allows for one other basis for decision: ex aequo et bono, basic justice and fairness. The Statute of

the International Court of Justice (Art. 38(2)) permits decisions ex aequo et bono only if specifically agreed to by the parties. There appears to be growing recourse to equitable principles as a legal "standard" and thus a general source of law. Examples are the several provisions for resolving boundary disputes under the new Convention on the Law of the Sea (not yet in effect).

Processes by Which International Law Is made or Applied: International law is made and applied through a process of claim and counterclaim among competing nations. The process can take the form of negotiation which results in an international agreement or other formalized outcome. Or it may be much less formal, leading to an informal consensus which could be characterized either as customary law or general principles of law. Or there may be no determinate outcome.

For example, when a stream is polluted in an upstream state, and thereby rendered useless to a downstream state, there is likely to be claim by the downstream state against the upstream state. This claim is likely to be expressed as a claim of violation of international law; the response by the upstream state is also likely to be expressed as based on law. The ultimate outcome may be a compromise between the interests of the competing states, or a subordination of the interests of one state to the interests of the other. The upstream state may pay damages to the downstream state and promise to limit the further discharge of pollutants. Or the downstream state may acquiesce in the pollution. Any solution demonstrates a continuing practice which may support the proof of a customary rule of law. There may or may not be clear, concurrent statements that the outcome is required by law. Both states may adhere to their original claims, and ascribe to expediency their adherence to an

outcome which accords less than their claimed rights. Such informal consensus is inherently unstable; all a nation need do to show that it is not bound by a custom is to act in violation of the purported rule while denying that the law requires such conduct. In this process, the respective foreign ministries function simultaneously as claimant, legislator, and judge.

At the opposite extreme is the possibility of one state imposing a solution on another state by coercion. Today such an approach is considered unlawful except as an act of individual or collective self-defense. Special instances of self-defense are given the technical names retorsion and reprisal. Retorsion is an unfriendly act which is not illegal, but which nations would not normally undertake toward one another. Such acts serve primarily to reinforce the informal process of claim and counter-claim by which custom is created. Reprisal is a stronger act -- one which is normally illegal, but which becomes legal as retaliation for a similar illegal act by the object of the reprisal. (Suspending Aeroflot flights as retaliation for the KAL incident is a retorsion; shooting down a Soviet airliner would be a reprisal.) There is controversy whether reprisals can ever be lawful today. The better view is that a reprisal is lawful so long as it is similar in kind and reasonably proportionate to the precipitating act of the other state. Even where coercion is effective, the outcome is stable only so long as the relative power positions of the involved states do not materially change.

Between the extremes are several forms of negotiation. These processes are varied and quite complex, and may be bilateral, multilateral, regional, or universal in scope. The outcome can express international

custom or general principles of law, or may produce a binding international agreement.

A related process is mediation or conciliation. Mediation is a process of negotiation expanded to include one or more states (directly or through international organizations) which are not directly involved in the controversy. The additional states can serve as a channel of communication, propose solutions, or in some cases may impose a solution. The mere presence of the additional states exerts informal pressure to reach an agreement. The states might impose economic or other sanctions on recalcitrant parties; the United Nations is authorized to impose military sanctions.

Controversies may also be settled by recourse to an existing international organization with jurisdiction over all the parties and over the controversy. The United Nations claims universal jurisdiction, and has most nations in the world as members. Solutions are essentially legislative rather than negotiated; the final outcome is an expression of community judgment expressed by some species of majority vote. The U.N. General Assembly has only power to recommend, although such a recommendation may be evidence of customary law. The Security Council can order compliance with its decision so long as the Council is convinced that the controversy is a threat to peace, but the Security Council is generally paralyzed by the permanent member veto.

Prior to the mid-19th century, arbitration of international disputes was rare. When arbitration became common in the late 19th century, it was on an ad hoc basis. The creation of the Permanent Court of International Arbitration (PCIA) in 1907 stabilized a few procedures. Both the Permanent Court of International Justice (established in 1920) and its present successor, the International Court of Justice

(established in 1945), are clearly rooted in the tradition of international arbitration. Litigation remains unimportant.

The International Court of Justice (ICJ) can only hear cases if the parties consent to the jurisdiction of the Court. While some states have given a blanket prospective consent to the Court hearing cases involving that state, this consent to "compulsory" jurisdiction may be withdrawn at any time before a suit begins. Further, all states in a dispute must consent to "compulsory" jurisdiction or none are bound to appear before the Court.

While only states can be parties in litigation before the Court, U.N. organs can request advisory opinions from the ICJ. An advisory opinion can be an indirect method of invoking compulsory jurisdiction over a dispute, but this tactic is seldom used. To defy the Court's decision casts the defying state in the role of lawbreaker more clearly than anything else a state might do.

Conflict of Cooperation over Consumptive Uses

When fresh water is used in ways which are incompatible with use by others, the first use is called a consumptive use. Consumptive uses can involve removal of water in such a way that it is not returned to the source for others to use. The principal example is irrigation. Depending on hydrography, some portion of irrigation water may drain back to its source, but most does not return. Another consumptive use may involve near total return of extracted water, but in such altered quality that the water is rendered unfit for use by others. This latter is characteristic of water used to transport municipal wastes or in industrial processes. Sometimes even small return flows may be so

polluted as to render much larger quantities of water unfit for competing uses.

Ordinarily, conflicts over consumptive uses are more difficult to resolve than conflicts over nonconsumptive uses where all one need do is assure that all interested parties have access to the river, lake, or other source. The need to solve problems of sharing and managing consumptive uses of water, particularly in dry areas such as the Middle East, played a central role in the evolution of early centralized states combining all territory within a river basin. From the time of the Assyrian empire up to 1918, four of the six rivers in this study -- the Euphrates, the Jordan, the Litani, and the Orontes -- were with brief interludes contained within a succession of large empires covering large portions of the Middle East. The lower Nile was also after included within the imperial system, although the Nile basin is so large and varied that no state or empire ever succeeded in uniting the entire basin under a single regime. The Shatt al-Arab, not used consumptively, most often served as a border rather than as the nucleus of a state or province.

One legally significant consequence of this pattern is that prior to 1918 none of these four rivers could be said to raise questions of international law. The post-World War I settlement partitioned these formerly unified river basins between British and French mandates, and a residual Turkish state. This process was carried further when the mandates became independent, with Syria and Lebanon emerging from the French sphere, and Iraq, Israel, and Jordan from the former British Mesopotamia and Palestine. Similarly, the independence of Egypt, the Sudan, and Uganda put an end to British control of most of the Nile basin. This

process of devolution of formerly unified regimes has created controversies over the water of several of these rivers.

The process of conflict has been most intense and sustained over the Jordan. Because of this, and because more information is available on the Jordan as a result of the sustained intense conflict, this part of the study will focus primarily on the Jordan basin.

The Jordan in International Law: Although the Jordan is a small river, its basin is divided today among four nations - Israel, Jordan, Iraq, and Syria. There are ongoing disputes between these states over what the true land boundaries are. At least one group which does not constitute a state - the Palestinians - has significant claims to the water of the river. All of this complicates the legal situation of the river.

Throughout the Middle East agreements attempting to regulate the use of rivers which cross international boundaries are sparse. Even treaties setting a boundary along a river rarely made provision for sharing the water among consumptive users. The few agreements sharing water have been bilateral, even when three or more states share the basin. These agreements have generally taken the form of restrictions on upstream uses so as to preserve water for users in the downstream state.

During the mandatory period the British and the French recorded several agreements of this pattern. The French agreed not to develop upstream consumptive uses in Syria and Lebanon; they agreed to permit Palestinian authorities to construct works in Syria for the benefit of downstream users.

In addition to the agreements of 1920, 1922, and 1931, the mandatory system provided legal machinery for resolving disputes. The Council of the League of Nations was responsible for supervising the process.

AD-A141 992

WATER AS A SOURCE OF COOPERATION OR CONFLICT IN THE
MIDDLE EAST(U) PENNSYLVANIA UNIV PHILADELPHIA MIDDLE
EAST RESEARCH INST T NAFF 14 MAY 84 MDA908-83-C-1542
F/G 8/8

3/3
NL

UNCLASSIFIED

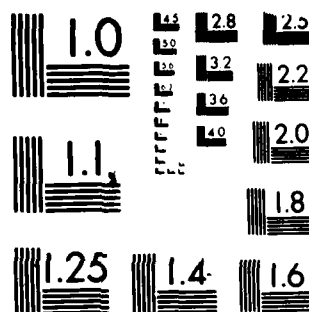
END

DATE

FILMED

7-84

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

mandates, and the mandatory powers were bound by agreements with the League to submit disputes over the conduct of the mandates to the Permanent Court of International Justice.

The apparent lack of friction over water during the mandatory periods reflects the strong interest of the British and French in cooperating in Europe against Germany and in presenting a united front against the indigenous peoples in the mandates. It also reflects the generally undeveloped state of water use in the region during the mandatory period. Thus, Anglo-French water agreements were never implemented during the mandates, and have been treated as a dead letter since the mandates ended.

Nor can any other institutional arrangements from the period of the mandates, such as the Rutenberg Concession, be said to settle rights under these agreements. These institutional arrangements have been succeeded to by separate groups with inconsistent claims which have never been settled.

In the absence of a binding international agreement, determination of the relative primacy of competing claims to the waters of the Jordan River falls back on the nebulous notions of customary law or general principles of law.

Worldwide, the claims and counterclaims arising out of competing consumptive uses fall into clear patterns. The resolutions of these controversies do not. Characteristically in such controversies, the upper riparian state claims that its territorial sovereignty is absolute, i.e. that it is free to do whatever it chooses with the water within its borders regardless of the effects of conduct within its borders on any other state. (This view was once the dominant view of riparian rights between private owners in England, but it has been abandoned at least

since the 18th century. Today such a view is found in Anglo-American law only in certain states with regard to groundwater.) Internationally, upper riparian states have never persisted in the claim of absolute territorial sovereignty when the dispute was truly over water.

Lower riparians usually begin the controversy with a claim that they are entitled to have the river come down without change in its natural condition. (In Anglo-American law, this is the natural flow theory or riparian rights, dominant in the 19th century and occasionally upheld today.) Lower riparian states have never persisted in such claims; the one time such a claim was made to an arbitration tribunal, the tribunal rejected the claim to the absolute integrity of the river.

Controversies have generally been settled by treaties which express community of property in the river. These treaties, and the few arbitral decisions, have been tailored to meet the special needs of the particular dispute over the particular basin. The only general principle to be abstracted is the well-known maxim of "sic utere tuo ut alienam non laedas" — "use your own so as not to cause an injury to another." In application this becomes the rule that any use of the water is permitted so long as it does not cause unreasonable injury to another rightful user. In Anglo-American law, this is the reasonable use theory of riparian rights. This approach has been applied by the Supreme Court of the United States to settle controversies over competing consumptive uses of water between various states. In the Supreme Court this is called "equitable apportionment." This approach is too vague to serve as a rule of decision in the absence of an impartial institution to resolve disputes, and has not been successful in cases involving water shortages. A strong

administrative structure is required to determine and administer water policy over a large region – preferably an entire river basin.

A variant of community of property theory has been termed the theory of restricted sovereignty (also restricted integrity). In this concept, the right to consumptive use of water is tied to more or less objective criteria of need. Common criteria have been either historic use or another single factor of correlation. Historic use, akin to prior appropriation doctrine in the western United States, depends on highly accurate records over long periods of time and a comprehensive administrative structure – both lacking in the Middle East. An alternative method is to divide the waters of a river basin in proportion to the relative uses of the different states at an agreed baseline date. (This approach has been used in the United States with regard to groundwater under the name of correlative rights.) Instead of such historic use, the right to use water is sometimes allocated in proportion to each state's area of arable land, or in proportion to each state's population. (This is also known as correlative rights in disputes between private or municipal users of groundwater in the United States.)

The variety and complexity of solutions to controversies over consumptive uses of water suggests that there is no certain customary rule for decision. Rather, the solution must come by way of negotiation, mediation, or arbitration ex aequo et bono – solutions which have thus far been impossible in the Jordan controversy.

The most one can clearly demonstrate is that there is a customary rule that no state has a right to extract water from a watercourse if that state is not riparian to the watercourse. This means that the river or other watercourse must at some point either pass through the territory of the state, or at least touch its borders (ripari is Latin for river-

bank). This rule is of little help in the Jordan. Before 1967, all four states involved in the conflict were clearly riparian. At present, Israel has almost eliminated Lebanon and Syria as riparians in fact, but nearly everyone recognizes that the territory Israel has occupied in Lebanon and Syria is legally part of the two states from which the territory was taken. So long as this continues the case, each of the four state will continue to have a legal claim to share in the water of the Jordan. This claim will be recognized by the general community of states, even though the necessary means for reconciling interests is not provided by the law which legitimates the claims.

Arguably, a corollary of the riparian rule is that water must be used within the watershed of the stream from which the water is extracted. Several lower riparians have made such claims, but there are few cases where such a claim has ultimately affected the outcome of the controversy. Rather, the version of the watershed rule which does seem to be a corollary of the community of property version of the riparian rule is that the water cannot be used outside the watershed if such use would unreasonably injure the rightful uses of the other riparian states.

The lowest riparian would never be limited by this rule. An upper riparian like Israel might also not be limited if the return flow from use within the Jordan Valley — even without removal from the Valley — would be so small or of such poor quality it would be of no use to a lower riparian like Jordan.

If general custom proves inconclusive, one can seek among general principles of law recognized by "civilized nations" for helpful rules. One principle found in legal systems throughout the Middle East is the principle that domestic use takes priority over any other competing use.

Application of this principle is not easy in the Jordan Valley since there is neither a universally agreed, nor a locally agreed, common definition of domestic use. (Does it include only direct human consumption, or does it include "household" livestock and gardens -- or swimming pools?) Further, several interested states or groups challenge the legitimacy of the presence of the Jewish population in Israel; at least inferentially, this challenges the legitimacy of their domestic use. Moreover, no society will long survive if the only water it can use is for purely domestic uses. One still must determine how to allocate water among other uses, and there is no general agreement about priorities among other kinds of uses.

The claims made by the states which share the Jordan basin fit the patterns which are outlined above. Lebanon has consistently espoused the claim of absolute territorial sovereignty. This position reflects the fact that Lebanon is the sole riparian, or the uppermost riparian, of all streams of significance within its borders. The extreme expression of this position was the announced decision to divert the Hasbani River (a tributary of the Jordan River) into the Litani River which flows entirely within Lebanon. Israeli opposition blocked this.

Syria is an upper riparian to the Jordan and the Yarmuk (a principal tributary of the Jordan), but it is a lower riparian to the Orontes (where Lebanon is above Syria) and to the Euphrates (where Turkey is above Syria). Both of these rivers are of far greater significance to the economy of Syria than the Jordan and Yarmuk are. Probably as a result, Syria equivocated as to the claim it would press with regard to the Jordan and Yarmuk until 1964, when it adopted the classic upper riparian stance of absolute territorial sovereignty. Syria proposed to divert the Banyas tributary of the Jordan (and perhaps Lebanon's Hasbani

as well) to the Yarmuk, and to share the waters of the enhanced Yarmuk solely with Jordan. These proposals were squelched by the Israeli occupation of the Golan Heights.

Jordan is an upper riparian as to the Yarmuk, but a lower riparian as to the Jordan proper. Jordan as a result has usually shied away from the sorts of claims that Lebanon and eventually Syria espoused. Instead, Jordan has argued that it was entitled to the absolute integrity of the river system, and that other states cannot divert water out of the watershed of the Jordan. The former view would preclude any consumptive use by any other state in the basin. The latter view would permit only insignificant uses by other states. The Jordanian claim would preclude the use of the Israeli National Water Carrier. After 1967, the situation changed dramatically, as Jordan was no longer the sole lowest riparian. As a result, Jordan moved toward a position of community of property, as exemplified in secret negotiations recently mediated by the United States.

Israel is a lower riparian relative to all three Arab states, but also an upper riparian towards the lower reaches of the Jordan when it flows between the East and West banks. Until 1967, Israel espoused the community of property approach and rejected watershed limitation. After 1967, Israel eliminated Syria as an upper riparian, greatly reduced the presence of Jordan downriver through occupation of the West Bank, and intimidated Lebanon. As a result, Israel moved towards a claim of absolute territorial sovereignty. This posture was reinforced by the occupation of southern Lebanon which made Israel in fact, if not in law, the uppermost riparian on the Jordan proper.

The foregoing individual claims have been confused by attempts of the Arab states to coordinate policies, and by the Israeli use of water claims to open channels of negotiation with the Arab states. These tendencies nearly bore fruit in a complex series of negotiations mediated by the United States. These negotiations produced a series of plans collectively called the Johnston Plan (1953-1955). The final plan was formally rejected by the Arab governments, and accepted formally by Israel. Nonetheless, the plan seems to have been followed by the several governments, at least until the Israeli occupations rendered the relationships under the Plan obsolete. Despite its formal rejection, the Plan might be considered a rule of local custom since there was a clear practice of adherence for a time and since both Israel and the Arab governments have protested suspected noncompliance by the other states. However, abandonment of the Plan in practice may have occurred, or could possibly occur in the near future. In such a case, the local customary rule would be at an end even though there is no satisfactory replacement for it.

Since there is presently no surplus water in the Jordan, the tendency is to consider that any solutions to future problems will have to center on technical solutions to make more water available to Israel and Jordan. Still, one should not overlook the possibility of further negotiations over the waters of the Jordan and the Yarmuk. In fact, such renegotiation will be imperative if Palestinians on the West Bank secure an autonomous or independent existence. There is now no separate allocation for the Palestinians, and both Israel and Jordan insist that such an allocation must come entirely out of the other's share. Negotiations or some other mechanism of solution must be found not only to determine a Palestinian share, but also to create the necessary technical means for

diversion and delivery since the Jordan itself is too saline for use by the time it reaches the West Bank.

Groundwater in Israel: One primary alternative source for Israel is groundwater. Already before 1967 Israel was making such use of groundwater resources that salt water intrusion into the aquifers was a serious problem. After occupying the West Bank Israel imposed strict controls on the wells of the Palestinians. No new wells were permitted to be drilled (with the exception of a very few for strictly domestic needs). Pumping from existing wells was limited to the quantities Israel determined were being pumped before 1967. The surplus water was made available to seep down to the lower-lying Israeli reaches of the transboundary aquifers. Israel also licensed the highpower pumps of newly established Israeli settlements in the West Bank — with the occasional result that nearby Arab wells went dry.

This pattern of Israeli conduct appears to be in clear violation of the international law of military occupation. This law is largely the creation of the Hague Convention of 1907 and the Geneva Convention of 1949. While Israel claims to reject the Geneva Convention and adheres only to the Hague Convention, most states consider that both Conventions express general customary international law. If this rule is jus cogens then Israel would be bound. The United States seems to support the latter view, but one cannot claim that the question is settled.

Both Conventions are predicated on the assumption that military occupation is temporary. Thus the occupying power is to preserve the private rights and lives of the inhabitants of the occupied territory with as little change as possible. Military necessity, not the economic needs of the occupying power, is the sole justification for interference

with these lives and rights. Even public property is to be used solely for its original purposes. Viewed in this light, Israeli conduct would appear to be clearly illegal.

The applicability of these rules can be questioned both because of Israeli rejection of the claimed rules, and because of questions about the relevance of these rules. Israeli military occupation has continued in the West Bank for 17 years with only intermittent, and mostly indigenous, military opposition to Israeli administration. The predicate of strictly temporary military occupation, actively opposed by an external military force, does not apply. Arguably the restrictions on the occupying powers' activities also do not apply.

Whether illegal or not, the present situation cannot continue if real autonomy is negotiated for the Palestinians. The approaches that were discussed with regard to the competing consumptive uses for the Jordan River will be applied to the shared aquifers of the region despite the even greater technical uncertainties encountered. As with the River, the challenge will be to design a system of shared jurisdiction or common property which fairly accommodates the interests of the two peoples in such a way that they are encouraged to cooperate rather than to fight over the use of the aquifers.

Imported Water: Several schemes have been proposed for importing water into the region of the Jordan. Jordan has sought to import water from the Euphrates in Iraq. Israel has considered importing water from the Litani in southern Lebanon (which Israel now occupies), or from the Nile. Both Israel and Jordan have considered importing sea water into the Dead Sea.

In each situation where fresh water would be imported, the receiving state is not riparian to the river from which the water would come. Thus, the right to receive water is entirely dependent on the willingness of the exporting state to convey the water. Since the exporting state is the lowest riparian in each case, there is no chance that the export of water can directly injure a third state, but the upper riparians can refuse to restrain their own development for the benefit of a non-riparian state. With no ready means of deciding the relative merits of legal claims, the only realistic solution would be to negotiate with most or all upper riparians. Buying out these objections might prove prohibitively expensive.

To import water from the Litani will incur special political costs. If Israel seeks agreement by establishing an "autonomous" South Lebanon, Israel may find itself in a position much like South Africa with its "Bantustans." If no state other than Israel recognizes the regime, Israel will be permanently committed to the maintenance of a second regime under siege. Such an outcome is bound to confirm Arab fears of Israeli expansionism. Further, waterworks on the Litani might well become a flashpoint of hostilities, with waterworks within Israel also becoming military targets. The lesson is clear -- using legal forms does not solve a problem, or make the conduct lawful. With a poorly developed international legal system, agreement or vendetta remain the two choices for settling most disputes.

The proposal to bring Mediterranean or Red Sea water to the Dead Sea for the generation of hydroelectric power presents legal problems in the Jordan basin if only because it would cause flooding along the margins of the Dead Sea and adversely affect existing mining operations. This is not lawful unless prompt, adequate, and effective compensation is

paid to those whose property would be affected. Israel would face a further legal difficulty if it chose to dig its "Med-Dead" Canal through the occupied Gaza Strip or West Bank. This would be in violation of the duties of an occupying state towards the inhabitants of the occupied territory. These questions will require negotiated settlement.

Policy Proposals for the Jordan: The users of water within the Jordan basin have been simmering on the edge of major conflict over water for 35 years. In an area with deep-seated hostilities from other causes, water should become a basis for bringing the parties together rather than for dividing them further. This is not so farfetched as it may seem. The parties have, with few exceptions, not targeted water works for military attack, which in itself shows some degree of tacit cooperation in the matter. Further, there is a millenium - long history of regional government which at least in part reflects the felt need for regional management of water. It is this tradition, rather than the more recent tradition of unremitting hostility, which must be built upon to produce regional cooperation, if not regional government.

In a world where the institutions for resolving international disputes through law are still remarkably inefficient, the major recent developments have been towards regional institutions, which appear better able both to develop relevant legal standards and to see that those standards are applied. Recourse to worldwide institutions such as the U.N. or the ICJ is of limited utility so long as the major powers disagree in the former, and the disputing parties refuse to submit to the latter. Thus, while one can discover apparently controlling rules of customary international law for settling water disputes in the basin, these are too abstract to be applied without some dispute-solving mecha-

nism to determine the proper application of these principles on the ground. Such an institution is more likely to be regional than worldwide.

The best policy for the United States to pursue is as mediator and conciliator, with a view towards fostering a cooperative solution to meet the present and future needs for water in the region. Ideally, this would take the form of a regional agency to plan and manage the water programs of at least the four countries within the basin. Such an agency should administer a relatively specific scheme of water priorities agreed to by all the concerned states. The United States, in cooperation with other possible mediating parties (e.g., Saudi Arabia, or the U.N.), could at least initially underwrite the costs of such an agency -- which might include at least some or all of the costs of importing water.

Such an ambitious scheme is designed to remove future controversies over water from the political-military sphere to a legal one. It will be difficult to bring about, yet it might be the first step towards regional cooperation on other issues which presently divide the states of the region. A less ambitious structure would be to create a conflict-solving structure without any specifically prescribed solutions -- an institution to bring the parties together on a regular basis without any prescribed schedule of priorities or other outcomes agreed in advance. Given the level of hostilities in the region, however, this may be more difficult to create and maintain than the more structured agency which is here called ideal.

One final avenue would be to adopt a solution without any need for a structure. A good example is the Indo-Pakistani agreement to partition the waters of the Indus Valley. Such a solution requires little or no

ongoing interaction between the states. The appeal of such a solution is clear when the states (and other groups) have a history of unrelenting hostility. Unfortunately, there is no clear way to develop such a solution in the Jordan basin. Israel and Jordan both need to develop major alternative sources of water in addition to the present sources. Merely partitioning present sources (say the Jordan to Israel and the Yarmuk to Jordan) solves nothing. And there is no clear way to partition the aquifers. In short, cooperation will be necessary for both Israel and Jordan. Israel may cooperate with Egypt or Lebanon. Jordan may cooperate with Iraq or Syria. Or they can cooperate with each other over the development of the Dead Sea power potential, the desalination of sea water, or other projects.

Once the need for cooperation is recognized, it is clear that the outcome will be more stable if it is regional rather than merely bilateral. This is especially true for Israel. At the same time each side should realize that such an arrangement will serve to some considerable extent to pull the other's teeth, but only at the cost of having some of its own teeth pulled as well.

A policy such as suggested here can only be accomplished as part of a larger settlement of the more fundamental issues that divide the region. Still, negotiations on water can begin and progress independently of negotiations of the other issues. In this way, water can lead to cooperation on a broader range of problems, just as cooperation over water can preserve and reinforce cooperation once peace is achieved. The danger is that failure in attempts to negotiate over water can (as at the time of the Johnson Plan) set back the search for peace and cooperation in the region. Yet peace in the Middle East without agreement over

secure adequate sources of water is impossible. The challenge for the United States is to see that such negotiations do not fail.

Other Rivers Used Consumptively: Three of the other rivers in this study which are used consumptively illustrate legal issues similar to the Jordan, albeit with less immediate potential for crisis.

The Euphrates is the nearest to being regulated by treaty. All the agreements are bilateral (Iraq-Syria, Iraq-Turkey, Turkey-Syria), but they include all riparian states. For the present this appears to be an adequate legal regime, although there are potential problems which might overstrain the legal regime. The central problem is the territorial and ideological conflict among the three states. Second is the probable growth of demand for water. In the next 25 years, the total demand may well outstrip the water available. These two problems alone make for an explosive combination, but there is a third problem. Iraq appears intent on exporting water to Jordan — a non-riparian state. As Iraq is the lowest riparian (except for Iran after the Euphrates reaches the Shatt al-Arab), there is no direct injury to the other riparian states. The upper riparians, however, may well refuse to honor commitments to refrain from using water themselves if that water will be exported to an outside state. This is especially likely when there is recurrence of Syrian-Jordanian hostility. While there is a history of successful recent mediation (by the World Bank, the U.S.S.R., and Saudi Arabia), a regional arrangement to manage water would stabilize and facilitate the management of such controversies as arise.

The Nile basin technically includes seven states, but only two of them have entered into treaty arrangements to manage the river — Egypt and the Sudan. This agreement, like all the bilateral agreements in the

Middle East. puts restraints on the upper riparian (the Sudan) in favor of protecting existing uses and early development in the lower riparian (Egypt). Sudanese plans to develop its uses of the Nile are already putting a strain on the treaty. Development by the other upper riparians -- especially Ethiopia -- poses even more threat to this agreement. Several upper riparians (in particular Ethiopia and the Sudan) are faced by secessionist movements which may refuse to honor agreements reached by the present central governments. Finally, none of the upper riparians could be counted on to restrain their own development to allow water to flow down to Egypt for purposes of export to Israel -- most of the upper riparians are ideological enemies of Israel. Thus the Nile seems headed for serious problems with little legal machinery for solving these problems. While breach of the Sudanese-Egyptian treaty would clearly violate international law, there is little Egypt could do but to fall back on threatened or actual coercion to enforce its rights. International law has even less to contribute to disputes involving other riparians.

The Orontes is even less subject to international legal regulation. There have been no formal agreements between Syria and Turkey, in large part because Syria claims the entire lower basin of the Orontes as its territory. (Syria has never accepted the alienation during the French Mandate of the Alexandretta-Hatay Province.) Distribution of the waters of the upper Orontes is covered by a 1972 agreement between Syria and Lebanon. Guarantees of that agreement are reputed to be one of the preconditions for the end to the Syrian occupation of Lebanon's Baalbek region. Despite this situation, there has been little controversy over the waters of the Orontes -- a situation which may change as more development takes place. The existing patterns may be held to amount to a

special local customary rule of law dividing the waters of the river, but it may not.

In contrast to the Euphrates, Nile, and Orontes, the Litani River has a unique configuration. The Litani lies entirely within Lebanon. Thus Lebanon alone has the right to use or control the waters of the river. Israel has long sought to have the Litani considered as a part of the Jordan River system even though there is no connection between them. There is no legal support for such a claim. Even the Lebanese plan to divert the Hasbani River (a tributary of the Jordan) into the Litani was not a recognition of such a link. Rather, it represents yet another manifestation of Lebanon's consistent espousal of a claim of absolute territorial sovereignty over both rivers. In other words, Lebanon claims the right to do whatever it chooses with the rivers within its territory irrespective of the effect of its conduct on any other state. The untenability of this claim is shown by the successful Israeli opposition of the Hasbani diversion plan. In these circumstances, Israeli ambitions to acquire the waters of the Litani can only be achieved through agreement with Lebanon. Such an agreement will only be workable if the agreement is truly with the Lebanese state rather than with some faction or fraction of the state. Given the state of Lebanese public life, this may prove workable only within the context of a regional arrangement such as is here espoused.

Controversies over Nonconsumptive Uses

Nonconsumptive uses of water do not materially alter the quantity of the water. Therefore, two riparian states seeking to make nonconsumptive uses of a single river are normally able to coordinate their activities

with little friction, since in principle the activities of one state do not preclude the activities of the other. Typical examples of nonconsumptive uses are navigation and the development of hydroelectric facilities. Fishing is also a nonconsumptive use with respect to the water, and also with respect to the fish so long as the combined catch of all fishermen does not exceed the maximum sustainable yield of the fishery. While such a use may temporarily or locally preclude another use of the river (as with the navigation of a narrow channel, or the construction of a dam at a particular site), the resulting controversies can usually be resolved by assuring all interested states of fair access to the river and equal right of use subject only to nondiscriminatory regulations designed to optimize the use by all. Examples abound around the world, ranging from the Rhine and Danube in Europe, to the St. Lawrence and the Columbia in North America, to the Amazon in South America, and the Congo in Africa.

In the Middle East the rivers are largely not significant for navigation, and little hydroelectric development has occurred. A noteworthy exception in both respects is the Nile River, but even there consumptive uses have always predominated over nonconsumptive uses. Thus the treaties dealing with the Nile have focused on the consumptive uses, and nonconsumptive uses have been sacrificed to some extent in favor of consumptive uses. Of all the rivers in this study, only the Shatt al-Arab is used primarily for nonconsumptive uses.

The primary use of the Shatt al-Arab is to navigate from the Persian Gulf, first to the Iranian ports of Abadan and Khorramshahr, and then to the Iraqi port of Basra. In theory, any controversy over the Shatt should be easy to resolve. The needs of the two states are easily coordinated, and there are numerous models from around the world to

follow in coordinating their activities. Ironically, the dispute between Iran and Iraq over the Shatt has been the ostensible cause of ongoing controversy for 140 years, which has culminated in the bloodiest war in the Middle East for at least several centuries. The war has thus far lasted 3-1/2 years and taken several hundred thousand lives. Clearly the Shatt is more a symbolic cause for conflict than the actual cause. Although a legal analysis of this controversy will lead to a more definite outcome than for legal analyses of controversies over consumptive uses, the conclusions reached will probably be no more helpful. Solution of the controversy over the waterway can only be expected if it occurs in the context of an overarching resolution of the deeper roots of the conflict between the two states.

The Shatt Boundary Treaties: The Ottoman and Safavid empires (prior rulers of Iraq and Iran) negotiated treaties over several centuries without ever precisely defining their frontiers. Finally, in 1847 the Treaty of Erzerum was negotiated with the mediation of the British and Russian governments. This treaty confirmed Iranian sovereignty over the left bank of the Shatt. The treaty did not expressly reserve sovereignty in the Shatt to the Ottoman Empire, and both governments seem to have exercised some authority in the river down to 1918. Nonetheless, both governments seem to have interpreted the language of the treaty as confirming Iranian sovereignty only to the edge of the river (the "left bank"), with the Shatt as a whole remaining under Ottoman sovereignty. Iran intermittently denied that it was bound by the treaty under a claim that its representative at the negotiations had exceeded his authority.

Whatever the merits of the Iranian claims with regard to the 1847 treaty, these claims were abandoned in 1913 in a protocol between the

Ottoman Empire and Iran confirming that the Shatt was within the Ottoman Empire with the exception of an anchorage at Abadan and another at Khorramshahr. The precise boundary was delineated by a British-Russian Commission in 1914. The Commission's work was overtaken by World War I and never ratified by the Ottomans. Nonetheless, the British followed the line while they administered Iraq.

When Iraq became technically independent in 1922, Iran refused to recognize the Iraqi government while renouncing the prior agreements on the Shatt boundary. Other boundary issues were raised as well. Iran claimed that the true boundary in the Shatt is the thalweg - the median line of the main navigational channel.

In 1937, Iran and Iraq signed a treaty which confirmed Iraqi sovereignty over the Shatt except for the anchorages previously assigned to Iran and a strip of about four miles near Abadan where the thalweg principle was adopted. The treaty provided for further negotiations to create a joint administration of the navigation and maintenance of the river. These negotiations never took place.

In 1969, Iran revived its claim to the thalweg line throughout that part of the Shatt which forms the boundary. Iran renounced the Treaty of 1937 because of the failure to negotiate the joint administration provided for in the treaty. Iran also revived its objections to the Treaty of Erzerum. After several years of tension, Iraq and Iran agreed to a treaty in 1975 which adopted the thalweg as the boundary in the Shatt.

Since the outbreak of war in 1980, both Iraq and Iran have denounced the 1975 treaty, each claiming that the other state breached the treaty by attempting to subvert the other. While such claims are insufficient to end the treaty, the mutual abrogation of the treaty puts it to an end.

Iraq claims that this revives the 1937 treaty, but this seems incorrect. The treaty of 1937 was mutually terminated in 1975, and Iran has refused to acknowledge the treaty of 1937 since 1969.

While there is today no applicable boundary treaty regarding the Shatt, there is a consistency in all the treaties regarding the Shatt which should be respected in any subsequent agreement over the boundary. This is that each and every agreement regarding the Shatt boundary has promised that regardless of boundaries the Shatt would "remain open on equal terms to the trading vessels of all the countries." (The treaties contemplate free navigation for war ships only from Iran and Iraq.) Since 1937 the treaties have further permitted the administering authority to levy dues on ships using the Shatt so long as the dues are devoted exclusively to the maintenance of navigation in the river. (Iran claimed Iraq's breach of this provision as one reason for its 1969 renunciation of the treaty of 1937.)

A Legal Solution to the Shatt Problem: Probably no solution will be possible on the Shatt until the conflict over ideologies can be deemphasized. That does not seem likely in the near future unless there is a major military breakthrough, or significant internal change, in one or both countries. If such a change comes about, there are clear legal principles on the basis of which an appropriate regime for the river could be established.

Internationally, the usual rule for boundary rivers is that the boundary follows the thalweg. This is thought to assure access to navigation to both states. In the case of the Shatt, however, Iraq can make a compelling appeal to equitable considerations of the sort often considered in deciding marine boundaries. The Shatt is Iraq's sole access to

the sea for Iraq's only major port. With an extremely narrow and swampy shoreline, no comparable port could be created elsewhere in Iraq. Iran, on the other hand, has a long shoreline with several significant ports. In fact, even before the war most of the oil formerly shipped down the Shatt by Iran had been diverted to Kharg Island and other ports. Further, the Shatt flows through a low swampy region carrying a heavy load of silt. As a result the thalweg itself is a frequently shifting line, the adoption of which may in practice be unsatisfactory. The ultimate demarcation must be unambiguous and acceptable to both parties if further controversies between them are to be avoided. Under the circumstances, it is probably appropriate that the 1975 treaty be considered as a recent aberration. The parties ideally should revert to the traditional boundary along the left bank of the river.

Given the heavy burden of national symbolism which both peoples have loaded onto the Shatt dispute, any agreement on boundaries in the Shatt may be difficult or impossible even if the ideological freight is unloaded. Perhaps the most lasting solution would be to develop a system which focuses on the interests of the two states to freedom of navigation in the river, while leaving the precise delimitation of the boundary at least temporarily in abeyance. The two states have long accepted in principle and practice the freedom of navigation for trading vessels from all nations and for warships of both Iran and Iraq. (This carries by legal implication the right to dock, to discharge and take on freight and passengers, and to perform any of the other activities which are the object of navigation.)

To assure freedom of navigation, each state must accept some limitation on its sovereignty to whatever extent it may exist in the Shatt. Thus both states must agree to refrain from interfering in navigation

bound to or from the ports of the other. It is only a small step from this to finally creating the joint authority contemplated in 1937. Given frequent shifts in the main navigation channel, constant dredging is necessary to keep the Shatt open to navigation. A joint authority, if funded either by contributions by the two governments or by levies on the ships using the Shatt, could insure a long-term growing practice of cooperation in the area.

Alternatively the parties could put the entire burden of maintaining the river on the party to whom sovereignty is assigned. This may well engender recurring controversies regardless of whether the left bank or the thalweg is used. Or the Shatt could be temporarily administered by the U.N. or some other international agency as a transitional stage leading to a permanent settlement.

Finally, one should consider the possibility of linking the Shatt settlement to the still unsettled continental shelf boundary between the two countries. Thus Iraq, which could be described as "severely geographically disadvantaged" by the configuration of its coast, could perhaps be persuaded to accept the thalweg line in the Shatt in exchange for concessions on the continental shelf boundary. Such linkage creates its own risk since a later dispute over the continental shelf could lead to a denunciation of the whole treaty, thus overturning the Shatt settlement as well.

Whatever solution the United States finally supports, it has almost no credibility with either Iran or Iraq. Thus it can only work indirectly through supporting mediation efforts by some fourth party such as Japan, which has successfully maintained commercial relations with both states, or perhaps by the Islamic Conference or the United Nations.

QUESTIONS FOR FURTHER STUDY

There are several questions which require further study before one can be certain of the appropriate policies which the United States ought to follow. Most of these are questions of fact rather than questions of law. Thus one ought to attempt to determine with respect to the Jordan whether Israel's export of water from the Jordan basin does in fact injure the Kingdom of Jordan or the West Bank. In other words, one should seek to determine whether the waters flowing down the Jordan below the confluence of the Yarmuk would still be of too poor a quality for use if Israel diverted no water out of the watershed. Respecting the Jordan, one might further ask for evidence as to whether Israel (or other states in the region) have in fact already violated the Johnston Plan allocations. Finally, one should ask for more details as to the United States' mediation effort in 1980 between Israel and Jordan respecting the waters of the river Jordan.

With regard to the Shatt, there is one interesting factual question: who maintained the river between 1975 and 1979 (when the thalweg line was recognized as the boundary)?

There are any number of factual questions regarding the other rivers of this study which might affect a legal analysis of the rights and duties or riparian states. In particular, one would like to know how well the actual practice on the ground complies with the formal agreements providing for shared responsibility for the rivers.

Two significant legal questions have not yet been addressed directly in this study of the six rivers. These are waste management (the preventing of pollution), and coordination of hydroelectric generation with other uses. Most river basin management schemes today consider the

problems of the basin in the context of multiple use management schemes. While in principle the problems of pollution and of hydroelectric generation will be dealt with in much the same way as diversion of water and navigation, respectively, these problems are not precisely the same and need to be separately considered in a coherent and comprehensive river basin or regional water management scheme. These questions were not addressed in detail here, both because of the time limitations for this study and because of the relatively limited information available. Perhaps with more time, more information could be found here or abroad.

MIDDLE EAST WATER
THE POTENTIAL FOR CONFLICT OR COOPERATION

**MIDDLE EAST WATER:
THE POTENTIAL FOR CONFLICT OR COOPERATION**

The 1980s have been designated by the United Nations as the "Water Decade." They may well be, especially in the Middle East — but not necessarily in the intended sense of providing minimal access to drinking water and sanitation for all people. Rather, the 1980s may be the "Water Decade" in the Middle East in the sense that during this period, or shortly thereafter, several potentially virulent international conflicts over water may erupt in the region and the internal development of certain key states may be ever more seriously constrained by water shortages, with major political repercussions. On the other hand, if ways can be found to manage these worrisome water conflicts, progress on water issues might possibly provide an impetus to cooperation over other issues and contribute strongly to pressures toward peace. This, at least, is an oft-expressed if oft-derided hope.

As it does physically, water runs both on and under the surface of politics in the Middle East. The surface phenomena are readily apparent, as when treaties are signed, complaints are taken to the United Nations, plans are debated, or border raids attack water facilities. Water, however, has often been seen as the primary strategic factor behind the political and military maneuvering in the Middle East. For example, just as Karl Wittfogel explained "oriental despotism" in ancient Egypt and elsewhere in terms of an "hydraulic theory of politics" (i.e., large scale water management required great concentration of power), so some contemporary analysts (Stauffer, Cooley, Stork) see Israel's regional

policy as primarily responsive to the "hydraulic imperative" (i.e., the quest for water is essential to national survival). From this perspective, Israel's foreign policy in the area directly reflects and is predicted by her water interests.

The argument runs as follows. More than a third of Israel's renewable water comes from the West Bank; consequently, she acquired and will not relinquish control of that territory. The Golan Heights command the vital headwaters of the Jordan and the main pumping station for Israel's National Water Carrier; consequently, Israel annexed and must command the Golan to prevent their diversion. The Sinai was revealingly dispensable because it only offered oil, not water. And Israel's third major military incursion, the invasion of Lebanon, is regarded by these analysts as at least in part an attempt to secure the lower Litani River waters, which seemed to be the only feasible source of additional water supply necessary to compensate for the fact that Israel is currently running out of renewable water. Finally, Israel may then have lost her motivation to remain in southern Lebanon when she discovered that, because of irrigation and other upstream uses, the Litani was now, at the point of most practical diversion, in Sharon's words, "just a trickle." Hence, water provides the analytic key to understanding Israeli foreign policy. True, false, or a mixture of both, such hypotheses are important, worth investigation, and revelatory of a significant perspective on regional affairs. Though physically shallow, politically Middle Eastern waters do indeed run deep.

Conflict

Conflict may be roughly defined as occurring when one actor blocks the felt interests of another. This blockage may be relatively passive, such as accidentally obstructing a goal sought by the other, or it may be aggressive, deliberately threatening the other's intended activities. The conflict may be perceived by either or both of the parties and/or by others. Of course, a perceived interest blockage may be mistaken, in which case one may speak of a false conflict. Though false in the sense that the perceived interest blockage is erroneous, such conflict may still be important, damaging and even durable. Nonetheless, it offers the possibility of resolution through perceptual correction. False conflict must also be distinguished from pseudo-conflict, that is, pretended conflict (to secure aid, involve others, satisfy public opinion, etc.) An issue is conflict that is perceived by both (or all) parties.

If the conflict is not perceived by the actor whose interests are blocked, it can be regarded as a latent conflict. It "surfaces" and begins to become volatile when it is perceived by the actor whose interests are blocked. If that actor attempts to do something about it and meets resistance, the conflict erupts or is activated. If both (or all) actors feel blockage of their interests, the intensity and complexity of the conflict usually rises. Conflict also frequently occurs when actors in established nonconflictual relations change or increase their interests or when alterations occur that inhibit continued realization of previously satisfied interests. These last conflicts are likely to be especially bitter (at least one major theory of revolution emphasizes them).

Other factors affecting the severity of conflicts are: (1) the nature of the interests involved (their number, salience, strength, interconnectedness); (2) the nature of the blockage (Who blocks? Is it deliberate? avoidable? legitimate? prolonged? early or late?); (3) the prospects for its elimination (power needs, costs, probability of success, tactics, timing); and so on. In fact, both conflict and cooperation are power relationships and, as such, involve one in consideration of all the key aspects of power. These will be brought to bear as necessary in the analysis of each of the six water systems. First, however, we shall focus on the question of water conflicts more generally. Can anything be learned from an examination of these cases that might fruitfully be applied to other water conflicts, at least in the Middle East and perhaps elsewhere? Do water conflicts tend to have some characteristic features, or is their variation essentially as great as the variation among all conflicts?

Interests and Issues

Although important in many places, water interests and issues are probably more significant in the Middle East than in any other region of the world. The reasons for this are not obscure. With limited exceptions, most of the Middle East is semi-arid or arid. "The Arab countries cover the world's most extensive arid zone," with the locations of their major cities determined by access to water from rivers or nearby mountains. Agriculture and animal husbandry have been the region's traditionally basic economic activities. Ethnic and nationality cleavages are pronounced and still in the process of adjustment. Population growth rates are generally quite high. Colonialism and

international intervention in the region have historically been strong, the former lasting until relatively recently and the latter continuing, leaving a legacy of conflict and suspicion. Under such conditions, water tends to be vital, while trust is low, conflict rife, and its peaceful management difficult at best.

Major water issues in the Middle East are complex, salient, intense, numerous, interrelated, technical – and hence extremely recalcitrant. One of the most confounding characteristics, complexity, is due to two features above all. The first is that water serves so many purposes or has so many uses. It is both an end and a means. Most obviously, it is used or needed for drinking, food preparation, waste disposal, sanitation, cooling, recreation, wildlife conservation, fishing, flood control, navigation, fire fighting, irrigation, soil preservation, industry, hydroelectric power, and aesthetic purposes. However, it is also used as a weapon both domestically and internationally (threatening diversion, promising supply), as a means to other ends (obtain de facto recognition from riparians), as a symbol ("our Jordan" – Begin), as a means of controlling development, as a trading item (Orontes water for acceptance of a Turkish Hatay), and so forth.

Second, partly because of these many uses but also for other reasons, water issues tend to be related to many other issues, such as survival, security, nationalism, demographic change, economic development, foreign policy, internal politics, ideology, the environment, etc. Water conflicts both provoke and depend upon conflicts in these other areas. Consequently, sometimes solution of the water conflict is a necessary precursor to solution of other types of conflicts, and sometimes other conflicts must be solved before the water conflict can be

handled, and sometimes combinations of both must be handled simultaneously. In many cases it is extremely difficult to determine just what the interconnections and the most effective solution sequences are.

How does such complexity affect the participants? How can an analyst deal with it? These are crucial and related queries. Both questions have been the focus of recent analytical scrutiny that has led to a promising increase in understanding and focusing research capacity, but which is still far from great predictive power. The "cognitive mapping" approach, developed by Axelrod and others, still appears extremely well-suited to clarifying interests and issues — a necessary component of the analysis of major water conflicts, as will be shown later. In our future research, we should like to develop and apply this approach more fully, mapping all national orientations to each water conflict and, where fruitful, also the approaches of critical subnational actors.*

The effect of issue complexity on participants is well summarized by Axelrod:

The picture of a decision maker that emerges from the analysis of cognitive maps is one who has more beliefs than he can handle, who employs a simplified image of the policy environment that is structurally easy to operate with, and who then acts within the context of his simplified image.

One obviously useful procedure is to compare the cognitive maps of an issue held by each major actor. This is done in order (1) to locate critical differences that may be determining policy and (2) to ascertain basically whether the issues are truly "real" (i.e., the perceptions are essentially similar and the problems lie in the presence of antagonistic

* Some special problems arise when mapping the cognitions of collectivities, but these will not be discussed here (see Axelrod 1976, pp. 239-243).

goals) or whether at least a significant part of the conflict is due to the utilization of discrepant cognitive maps that might be resolved by negotiation, mediation, good offices, external influence, etc. A related and perhaps no less helpful analysis is to compare a given actor's cognitive map of the issue with an "objective" map of the same issue -- i.e., a map representing some form of expert opinion. In the case of water crises, this is usually feasible and often illuminating.

In our preliminary research, we have had neither time nor resources to accomplish an extensive and systematic analysis of this nature. However, a very impressionistic, simplified and brief illustration of cognitive mapping and its usage may be helpful. In the figure on the next page, we present an elementary map of a generalized Israeli interpretation of the Jordan water conflict. The thickness of the lines indicates the perceived strength of the association among issue elements and the arrows suggest the general direction of perceived causal flows. One crucial omission from some cognitive maps is that the overall importance (the evaluation or utility) of the cognitive realm being mapped is not indicated. In the present instance, however, since "national interest" is a main component and is obviously of utmost importance, this limitation is not significant.

Several fundamental observations quickly emerge from the figure. Even at this abstract and condensed level, the strong interconnectedness of the water factor with other key factors for Israeli policy-makers is revealed. From the Israeli perspective, water is strongly linked to agriculture, since this is ideally and very often actually irrigated

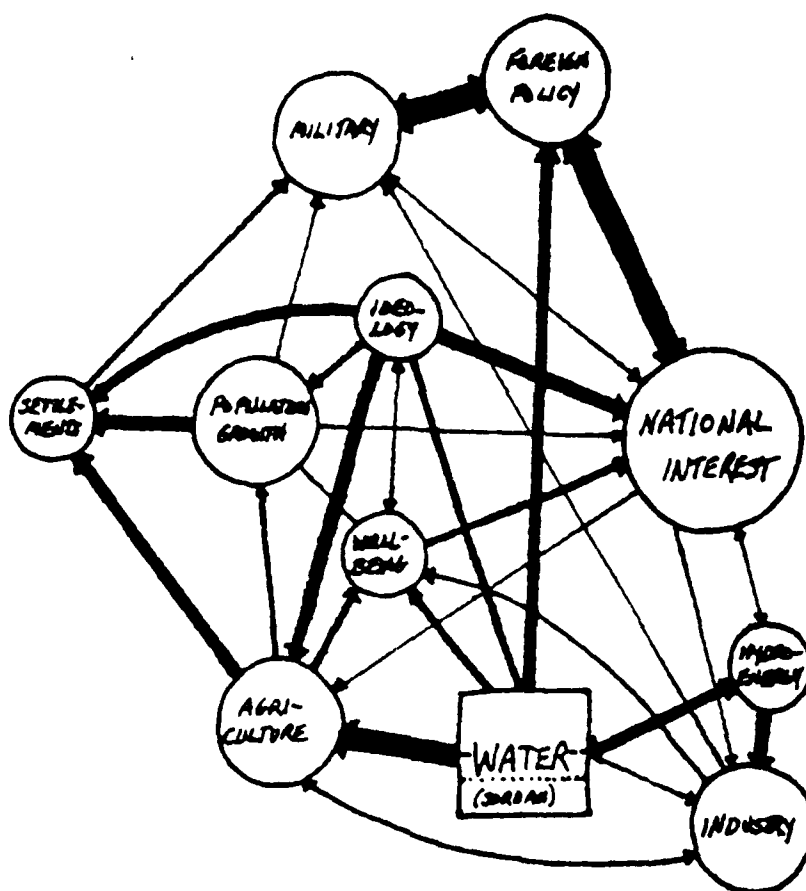


Figure XX. Cognitive map of the general Israeli perspective of the Jordan water issue (and others).

agriculture. Dry farming is not the prevailing image. A fuller map would interpolate an "irrigation" cognition between "water" and "agriculture."

Agriculture, in turn, is strongly linked to "ideology." The Israeli and Zionist aspiration to "make the desert bloom" (Ben Gurion), of "national redemption through a return to the soil" (Gordon), makes water, according to their own change of metaphor, the "lifeblood" of the system — "a prerequisite for a new society" and a "nation rooted in its land." As Gainor (1978) stresses, "water carries ideological weight" because of

its association with agriculture and is never, for Zionists, "merely another economic resource."

Similarly, agriculture, in its turn, is not merely an ordinary economic sector or even a model life-style. It is also linked to the crucial matter of settlements. Settlements are seen as essential for security purposes, "outposts" used as a first step in the consolidation of territory and to provide frontier resistance and thus time in case of attack. Agriculture settlements of 60-80 specially trained families accomplish this much more economically and effectively than urban-industrial communities. Water uses (in the National Water Carrier, irrigation, etc.) and also provides energy; it contributes directly and symbolically to national "well-being" ("potation," sanitation, recreation, aesthetics); it is necessary for population growth. Therefore, in the Israeli mind, as one Prime Minister (Sharett) put it, "Water to us is life itself." It is linked strongly to many other major beliefs and values. Indeed, it is regarded as a "primary need," as such overriding lesser concerns and justifying even the most drastic actions when threatened.

One can apply to cognitive maps a basic structural principle from cognitive consistency theories: the more central the cognition, the harder it is to change. In other words, the more connected or embedded a cognitive element, the more significant it is and the more resistant it is to alteration or replacement. Any such change requires the oppressive work of major cognitive restructuring, strongly disliked and resisted. Reshaping the basic Israeli view of the water problem would thus be extremely difficult.

Though not presented here, it is important to note that the Jordanian map of the Jordan water issue is quite similar to that of Israel.

Hence, we confront a true conflict – a clash of antagonistic values, not one based on perceptual discrepancies. Such issues are particularly intractable when the values involved have top priority, as they do here.

One approach to conflict resolution in this case, however, is suggested by the pattern of linkages displayed in the map. Water is not directly related and strongly related to "national interest;" instead, it is indirectly related, primarily through agriculture, security, and ideology. Water is seen as a means to these. Hence, one possible, though difficult and elusive, conflict resolution strategy might be to find substitute and noncompetitive means to these more basic objectives. A manifest approach is to reduce the association with security by providing other, less conflictual, mechanisms and guarantees. However, since water is so strongly embedded in the security thinking of the Israelis, progress in this area would not seem easy. For Jordan, though, the links appear weaker while the ties of water to economic and developmental factors are even stronger. A combined security-economic assistance approach might have better prospects there for reducing the tension over water that precipitates more general clashes.

It is also interesting to observe very briefly the differences in the cognitive maps held by individual key actors. For example, Ben Gurion's map had strengthened security-ideology associations (i.e., the lines in the upper half of the figure become relatively thicker) while Eshkol and Sharett had cognitive maps – to consider the three who shaped the strategic 1955 acceptance of the Johnston Plan according to Brecher (1975) – that place more emphasis on the economic and developmental aspects of water (heavier lines in the lower half of the figure). The two perspectives did not, in this instance, lead to policy conflict;

rather, they reinforced each other. But different patterns of connections for Israeli or other national policy makers might well be conflictual and be the basis for different internal and international behavior.

Finally, it is interesting to contrast the densely connected Jordan water cognitive maps held by Israel and Jordan with an opposite pattern. A good illustration is the Turkish image of the Orontes water situation. Here one finds a map with markedly fewer cognitive elements that are also much more sparsely and weakly connected. Settlements are not significant; agriculture is not so strongly linked to irrigation; hydroelectric power is more emphasized; and, most of all, the associations with security factors and ideology are greatly attenuated. Not surprisingly, a summary measure of perceived Turkish interests in this water source and the importance to her of associated issues would be much reduced, with concomitant diminution of conflict potential.

Apart from the features of water issues brought out by cognitive mapping, several other general characteristics of water interests and conflicts warrant mention. One key tension-multiplying factor is that these issues are heavily infused by notions of legitimacy. In essence, felt legitimacy tends to exacerbate conflicts, leading actors to define their interests as "rights" and to push and defend them more vigorously than they would otherwise do. The sense of "outrage" provoked when one feels wronged or has his rights denied is a cardinal contributor to violence.

Legitimacy becomes especially salient when actors of profoundly different types are thrown together by history, geography or chance. For example, Israel is a relatively modern state, Western in orientation. Her neighbors, with the uncertain exception of Lebanon, are transitional states, more Arab and Eastern in orientation. These differences are

clearly reflected in patterns of water use. Israel consumes several times as much water per capita as her Arab neighbors. Different reference groups lead to different interpretations of the legitimacy of this consumption, fueling existing hostility. Again, eighty percent of Israel's water is used for agriculture, though that agriculture involves only about fifteen percent of her population. In Syria, by contrast, the largest segment of the population depends directly on agriculture. Hence, a Syrian view sees its water needs as more legitimate than Israel's, while, as previously noted, the Israelis regard irrigated agriculture as the ideological foundation of their state. Discrepant positions so heavily laden with felt legitimacy on both sides sharply increase the likelihood and virulence of conflict. Other examples abound of divergent notions of legitimacy in Middle Eastern water crises.

One common strategy for conflict resolution is issue decomposition and piecemeal solution. A large issue is broken down into relatively independent and supposedly more manageable subissues which are then resolved one by one, reducing complexity and generating momentum, trust and goodwill that progressively ease remaining problems. A difficulty with this approach, often leveled at the Camp David Accord, is that one may merely "skim off the cream," leaving a very hard residue. The process halts after the readily manageable issues are dealt with, providing no easy entree into future negotiations over the tougher problems that remain. In water conflicts, this dangerous hiatus can most readily occur after some of the more neutral technical problems are dispatched without resolving the fundamental political conflicts and the water problems associated with them.

The situation is sometimes further confounded in the Middle East by one side's explicit perception of and resistance to what it calls a "piecemeal" ("one piece at a time") approach. Very briefly, the Arab countries usually see the Jordan water problem as inextricably linked to the Palestinian problem. They see Israel as trying to pick them off, one by one, via the strategy of separate peaces. Moreover, the Palestinian question may well be the only durable basis for Arab unity. Hence, piecemeal resolution of aspects of the Jordan water conflict is often suspect and rejected on these more global strategic grounds.

Water issues vary according to water supply. This is rather obvious in most respects, but some facets of that variation are not often noted and are especially germane. In particular, full utilization of available water and water shortage constitute thresholds of change that produce qualitatively different issue relationships. For instance, "when there is no slack in the water supply, policy makers cannot afford, politically and economically, to calculate the benefit-cost ratio of another single water project alone; the calculation must take into account the system as a whole" (Galnoor). Under shortage conditions, climatically induced variations in the water supply that can be tolerated under other circumstances become critical. Internal power-political problems are also given a qualitatively new cast under shortage conditions, as discussed later. More profound analysis of issue and power alterations under full utilization and shortage is another important area for future research, given urgency by the fact that the Jordan systems are reaching these thresholds now and the Euphrates may soon follow.

A last factor complicating water issues in the Middle East is the degree of international interconnection among these systems. Without too great a demand on the imagination, one can see a series of linkages

stretching from the Nile to the Shatt al-Arab. The possibility of transferring Nile water into southern Israel to ease the strain on the Jordan and West Bank was Sadat's "trump card" with which he intended to solve the Palestinian problem (the quid pro quo was West Bank autonomy). However, he misperceived Israel's water interests and underestimated domestic Egyptian repercussions. The Jordan is, of course, associated with the Litani through Israeli and Arab water policies, claims, and actions of various sorts. The Litani and the Orontes figure together in water policy planning in Lebanon, while the Orontes and the Euphrates are major systems in Syria's water regime. Finally, the Euphrates links Syria, Turkey, Iraq and even Jordan (through Iraqi proposals) before merging with the Tigris to form the Shatt al-Arab, the locale for the border conflict between Iraq and Iran.

The various contemplated trade-offs across these interrelated systems need not be delineated here; the primary point is simply that each of these water courses generates issues that impinge upon issues associated with other water courses. Although not hydrologically true, cognizance of the political and economic connections suggest that it is sometimes useful to entertain the idea of a general Middle Eastern water system -- a sort of hydro-political economy, the hydraulic aspect of the international relations of the Middle East.

**Modeling Water Conflict:
Interests, Riparian Position, Power**

We have discussed, at least generally, an approach to the clarification of interests and issues, together with some of their more significant features, in Middle Eastern water conflict. We must now add

two other basic components to develop what appears to be the simplest effective model of conflict potentials and outcomes for riparian-use types of conflicts. Five of our six water systems involve riparian (and quasi-riparian) use conflicts, while the sixth, the Shatt al-Arab, is actually a border dispute with few especially water-related issues.

At least three major factors shape riparian-use water conflicts:

1. Interests and issues;
2. Riparian position;
3. External and internal power.

Felt interests and perceived issues organize the motivations and cognitions of the participants, channeling them toward collision or cooperation. The stronger the interests involved and the greater their association with other strong interests, the greater the propensity to cooperation or conflict. If these interests are perceived as fostered or complemented by other actors, the press will be toward cooperation; if they are perceived as blocked by others, the drive will be toward conflict. If the blockage is seen as deliberate, avoidable, illegitimate, and occurs close to goal realization, the thrust toward conflict is increased. Moreover, such factors accumulate.

Blockage plainly does not always lead to conflict. It is frequently constrained or suppressed by considerations of power. In the simplest cases, either the aroused actor does not see itself as possessing the potential power to reduce or eliminate the blockage, or, although it believes it possesses the potential power, it finds the costs of exercising it exceed the benefits anticipated from elimination or reduction of the blockage.

For riparian-use water issues, one power factor, though obvious and elementary, is sufficiently determinative to justify its separation from

the rest for special notice. This is riparian position. In general, we find that upstream position confers power advantages. From this position one can usually take actions that can only be contested or countered by a downstream opponent with considerably increased difficulty or cost. The upstream actor ordinarily can confront lower actors with faits accompli whose alteration is far more demanding than the original actions. Diversion, overuse, contamination, and flow delay are more easily available according to one's position on the riparian totem pole. The only qualification of note seems to be an adjustment for flow; being upstream from the water course's significant flow (i.e., before it gathers its basic strength) reduces power accordingly. But otherwise, upstream position confers clear power advantages. One from a multitude of examples of this is Israel's forcible alteration of her riparian position from being originally downstream on all important Jordan tributaries except the Dan to a controlling upstream position on all except the Yarmuk.

Some very tentative conclusions produced by using this model and applying subjective weights ranging from one (weak) to five (strong) are displayed in the tables below, each representing a riparian-use system.

Euphrates				Nile				Orontes				Jordan			
Int Rip Pwr				Int Rip Pwr				Int Rip Pwr				Int Rip Pwr			
Tur	3	5	5	Eth	2	4	1	Tur	1	1	5	Leb	2	2	1
Syr	4	3	3	Sud	4	4	2	Syr	3	4	3	Syr	2	2	3
Irq	4	1	4	Egt	5	1	5	Leb	2	3	1	Jor	5	3	2
												Isr	5	4	5

We shall leave the justifications for the judgments expressed in the table for a final report. At this stage, they are to be regarded as exploratory. Future work will also attempt to reduce the subjectivity in such judgments and furnish clear, explicit and replicable criteria determining each type of judgment. It may be necessary to adjust the weighting scheme. Now, we shall merely indicate the types of insights provided by such an approach.

In general, conflictual potential is reflected in relative equality of overall rankings, especially when there is no higher-ranked actor with strong interest. Thus, Syria and Iraq are, after all, in a conflict position over the Euphrates, particularly under conditions of full use or shortage. Turkey is in the most advantageous position of all, but her lower degree of interest inhibits her dominance of the situation. Regarding the Nile, there is no actor scoring above Egypt and the Sudan, whose relative equality of position offers conflict potential. This has been overcome or managed up to now; but if these conflict managing constraints should weaken and the Sudan should choose to exploit her advantaged riparian position despite Egypt's power superiority, serious tension might emerge. The Orontes situation is a relatively stable pattern. The most powerful actor has very little interest. The next most powerful actor is most interested and is also in the best riparian position. Finally, for the Jordan water system, the data also are revealing. When Israel was in a relatively poor riparian position, the prospects for trouble were great, since she had strong interest and power. Now, as far as the Jordan waters alone are concerned, Israel dominates the scene.

Quite clearly, in these estimates, one of the most important and difficult tasks is to determine the relative power of the interested actors, particularly since both external and internal power configurations are critical. Externally, a cardinal factor is obviously military power. The ability to project military power against diversionary water works, usually meaning air power, missiles, and artillery, has special significance, as do defensive capabilities against such force. Much of Israel's success in violent conflict over water rests upon her military superiority in these area.

Internal power considerations also frequently loom large for water issues. One manifest response from Israel to the exhaustion of her renewable water resources would be to downgrade the importance of agriculture, which consumes eighty percent of her water. Industry yields about thirty times more output per unit of water input. However, not merely ideological currents but also a disproportionately strong agricultural lobby work against such a policy. Future research should be directed toward understanding the telling domestic power of these interests. Domestic power arrangements also mold the water policies of other Middle Eastern nations. We know much less about them, however, than we do about Israel. Repairing this deficiency insofar as possible should have high priority.

This is the general framework within which the case-by-case analysis of the river systems will be conducted.

SELECT BIBLIOGRAPHY

SELECT BIBLIOGRAPHY

Arab Report and Record
Foreign Broadcast Information Service
Keesings Contemporary Archives
Le Monde
New York Times
Times of London

Abel, Le P. F.- M. Geographie de la Palestine. J. Gabalda et Cie. Paris. 1967. 2 vol. 3rd ed. (French)

Abu Jaher, Faiz S. "Eisenhower, Israel and the Jordan Valley Scheme," Middle East Forum. Vol. 45, no. 2, 1969. pp. 51-63.

Agarishev, A. "The Offering of the Euphrates," Komsomolskaya Pravda, Jan. 29, 1972 (Russian)

Allen, Harry S. and Volgyes, Ivan, eds. Israel, the Middle East, and U.S. Interests. Praeger, NY, 1983.

Amerah, Mohammed. The Israeli Mediterranean-Dead Sea Canal and its Impact on Jordan and the Occupied Territories Royal Scientific Society, Amman, Jordan, 1982, 67 pp

Amin, S. International and Legal Problems of the Gulf, 1981.

"Arab World Digs in Over Canal," Eight Days, Oct. 31, 1981.

Amiran, David, H.K. "Geographical Aspects Of National Planning In Israel: The Management Of Limited Resources," Institute Of British Geographics, Volume 3, No. 1, 1978. pp. 115-128.

Bari, Zohwal, "Syrian-Iraqi Dispute Over the Euphrates Waters," International Studies (New Delhi), Vol. 16, no. 2, Apr.-June, 1977. pp. 227-244.

Bazua, Sar Shaher, "The Euphrates Serves the People", Sekskaya Zhizn, Feb. 28, 1982. (Russian)

Bender, Friedrich, 1968, Geologie von Jordanien: Gebruder Borntraeger, Berlin & Stuttgart, 230 p.

_____, 1974, Geology of Jordan: Trans. by Moh'd Kamal Khdeir, Gebruder Borntraeger, Berlin & Stuttgart, 196 p.

Berber, F. F. Rivers in International Law, 1959.

Berkofsky, L. et al. Settling The Desert. Gordon and Breach (London, 1981).

- Bochenski, Feliks and William Diamond, "IWA's In The Middle East," Middle East Journal, January, 1950, pp. 52-82.
- Beaumont, Peter, "The Euphrates River-an International Problem of Water Resources Development," Environmental Conservation, Vol. V, no. 1, pp. 35-43.
- _____, The Middle East - a Geographical Study: John Wiley and Sons, 1976.
- "Better Dead than Red or Med?" The Middle East Oct. 1980:90-91
- Boulos, B. F., 1965, Tourist map of Lebanon: National Economic Service, 3rd series of scientific publications.
- Brilliant, Joshua, "Water in the Hills," Jerusalem Post Magazine, May 4, 1979, p. 14.
- Burns, E.L.M. Between Arab and Israeli, Institute for Palestine Studies, Beirut, 1969. (reprint)
- Caelleigh, Addeane "Middle East Water: Vital Resource, Conflict, and Cooperation". In: A Shared Destiny - Near East Regional Development and Cooperation Praeger, New York, 1983, p
- "Canal will 'finalise Israeli annexation'" Eight Days, Dec. 26, 1981, p.35
- Cantor, Leonard, A World Geography of Irrigation, Praeger, New York, 1970, pp 252
- Caponera, D. Water Laws in Moslem Countries, 1954.
- Cassell, Michael, "Urban Water Supplies And Sewerage-Current Development Projects," Middle East Annual Review, Rand McNally 1979.
- Clagett and Johnson, "May Israel as a Belligerent Occupant Lawfully Exploit Previously Unexploited Oil Resources of the Gulf of Suez" American Journal of International Law, Vol. 72, 1978, pp. 556-585.
- Clawson, Marion, Landsberg, Hans and Alexander, Lyle, The Agricultural Potential of the Middle East, Elsevier, New York, 1972.
- Cooley, John "The Hydraulic Imperative", Middle East International July 22, 1983, pp. 10-11.
- _____, "Syria Links Pullout to Guaranteed Access to Water" Washington Post, Jun. 8, 1983.
- _____, "The War Over Water," Foreign Policy, No. 54, Spring, 1984, pp. 3-26.
- Cressey, George B., 1958, "The Shatt-al-Arab Basin": Middle East Journal, v. 12, p. 448-460.

Darin, Dan. "Dead Sea Channel," New Outlook, January, 1981, pp.17+.

Davis, Uri; Antonia, E.I.; Richardson, John. "Israel's Water Policies", Journal of Palestine Studies, Vol. IX, No. 2, Winter 1980

"Dead Sea Approved By Israeli Cabinet," New York Times, March 30, 1981.

"No Canals Now For Dead Sea?," Eight Days, October 3, 1981, pp. 38-39.

Dees, Joseph, L., "Jordan's East Ghor Canal Project," The Middle East Journal, Autumn, 1959, pp. 357-371.

Doherty, Kathryn B., "Jordan Waters Conflict", International Conciliation No. 553, Boston 1955

Doherty, Kathryn B., "Jordan Waters Conflict" International Conciliation, May 1965, Carnegie Endowment for International Peace, New York, 66 pp.

Edmonds, C.J., "The Iraqi-Persian Frontier: 1639-1938," Asian Affairs, Vol. 62, June, 1975, 147-154.

Edwards, C.J. "The Iraqi-Persian Frontier, 1639-1938" Asian Affairs, Vol. 62 (New Series, Vol. VI) June 1975, pp. 147-154.

El-Hinnawi, Essam, "Some Global Environmental Issues," Mazingira, Vol. 4, No. 1, 1980, pp. 46-59.

Eliav, Arie, "Alternative To A Nightmare" New Outlook, Feb-Mar, 1981, pp.4-9.

Eriez, Yaakov, "El Fatah Opposes Repairing the Damage in Naharayn in Exchange for Repairing the Ghor Canal in Jordan," Maariv, Sept. 25, 1969 (Hebrew)

_____, "The Ghor Canal" Maariv May 21, 1970 (Hebrew)

_____, "Ghor Canal Waters are Flowing to the Yarmuk After the Air Force Strike," Maariv, Aug. 11, 1969 (Hebrew)

_____, "The Ghor Water is Flowing Again," Maariv, Sept. 26 (Hebrew)

_____, "Jordan builds a New Dam on the Yarmuk," Maariv Apr. 11, 1975 (Hebrew)

_____, "The Jordanian Army is Checking the Ghor Canal to Prevent Terrorist Strikes," Maariv, Jul. 18, 1971 (Hebrew)

_____, "The Jordanians are Repairing the Ghor Canal," Maariv, Apr./20, 1970 (Hebrew)

_____, "The Jordanians have Renewed the Flow of the Yarmuk in the Ghor Canal After it was Damaged in a Raid," Maariv, Jul. 2, 1969 (Hebrew)

- _____. "The Jordanians Started Yesterday Repairing the Ghor Canal," Maariv, Apr. 16, 1970 (Hebrew)
- Fahim, Hussein M., 1981 Dams, People and Environment - The Aswan High Dam Case Pergamon Press, New York (etc), 187 pp.
- Fall, A. "Cabora Bassa - Les lumieres de l'avenir", in: "Cinq Barrages Cinq Problemes" Dossier L'Economiste du tiers monde no. 24 Nov.Dec. 1977, pp 25-27. (French)
- Farrell, William, E., "UN Aid Scrambles To Keep Beirut In Water," New York Times, July 7, 1982, p.1
- Fellows, Lawrence, "Jordan Reopens Irrigation Canal" International Herald Tribune, May 21, 1971.
- Feltz, Herman, R., A Reevaluation Of Water-Quality Investigations, Western Desert, Egypt, UAR, US Department Of The Interior Geological Survey (Cairo, Egypt, 1965).
- "The Fires of the Euphrates", Sotsialisticheskaya Industriya, Oct. 27, 1982. (Russian)
- Flemming Lauris, "The Secret Agreement was Broken-the Ghor Canal was Bombed" Maariv Aug. 18, 1969 (special service of LA Times)
- Galnoor, Itzhak "Water Policymaking in Israel" Policy Analysis, Vol. 4, 1978, pp. 339-365.
- Garbell, Maurice A. "The Jordan Valley Plan" Scientific American, Vol. 212, no. 3, March 1965, pp. 24-31.
- Gargouzi, Eva, "Land Reform in Syria," Middle East Journal, Vol. 17, no. 1 and 2, Winter-Spring, 1963, pp. 83-90.
- Gilman, Ernest, "Israel And The Iranian Oil Embargo," Round Table, No. 276, October, 1979, 291-307.
- Gischeler, Christian, Water Resources in the Arab Middle East and North Africa MENAS Resources Studies, Middle East and North African Studies Press Ltd, Cambridge, England, 1979 132 pp
- Giegengack, Robert, 1968 Late Pleistocene history of the Nile Valley in Egyptian Nubia, Ph.D. thesis, Yale University.
- Goichon, A.M. "L'Amenagement de la Vallee Syrienne de l'Oronte," Orient, Vol. 10, no. 37, 1966, pp. 149-171. (French)
- _____. L'Eau Probleme Vital de la Region du Jourdan Correspondance d'Orient, no. 7, Centre our l'Orient des Problemes du Monde Musulman Contemporain, Bruxelles, 1965, pp 128 (French)
- Golang, Gideon (ed), Arid Zone Settlement Planning, pp. 441-473.
- Goltz, Thomas, "Despite Problems, Syria effects a renaissance along the

- Euphrates," The Middle East Times, October 17, 1983, p. 11.
- Graham-Brown, Sarah "Water - How Israeli Policies Hurt West Bank Arabs" Arab Report, May 23, 1979
- Gutman, Emanuel and Jacob M. Landau, "National Leadership In Israel," Levi Eshko Institute, April, 1974, 163-197.
- Gustafson, C. Don, "The Irrigation Problem: the Israeli Experience," in Allen, Harry S. and Volgyes, Ivan, eds. Israel, the Middle East, and U.S. Interests, Praeger, NY, 1983, pp. 51-66.
- Habib, Cyrus "Investissements Hydrauliques ou Developpement Rural: Du project des Bureaux Techniques aux Realites des Accomodements" Revue Geographique du Lyon Vol. 94, 1979, pp. 283-288. (French)
- Hadawi, Sami, Bitter Harvest, Caravan Books, Delmar, NY, 1979.
- Hakim, Leila "Assouan - Un enorme potentiel", In: "Cinq Barrages Cinq Problemes" Dossier L'Economiste du tiers monde no. 24 Nov.-Dec. 1977, pp. 32-33. (French)
- Hareuveni, Meir, "Disputed Waters in the Yarmuk" unidentified clipping provided by Maariv archive 12/6/83 (Hebrew)
- _____, "The Jordan Valley Goes Back to Days of Calm," Maariv Nov. 11, 1971 (Hebrew)
- _____, "Jordan Wants a Cease Fire in Exchange for Repairing the Ghor Canal," Haaretz, Mar. 5, 1970 (Hebrew)
- _____, "The Jordanians Restart Ghor Canal Renovations" Maariv Nov. 9, 1971 (Hebrew)
- Heindl, L.A., A Preliminary Evaluation Of Report Preparation And Publication By The Egyptian General Desert Development Organization, US Geological Survey (Cairo, December, 1963).
- Hirsch, "Utilization of International Rivers in the Middle East," American Journal of International Law, Vol. 50, 1956, pp. 81-100.
- _____, "Water Legislation in the Middle East," American Journal of Comparative Law, Vol. 8, 1959.
- Holzle, Alvin, F., Photogeology And Photointerpretation In The New Valley Project, Western Desert, Egypt, US Geological Survey (Cairo, October, 1963).
- Hostie, "Problems of International Law Concerning Irrigation of Arid Lands," International Affairs Vol. 31, 1955, pp. 61-69.
- Hudson, James "The Litani River of Lebanon: An Example of Middle Eastern Water Development" The Middle East Journal Winter 1971:1-14
- H.M. King Hussein, Uneasy Lies the Head, Heinemann, London, 1962

- Inbar, Moshe, and Maos, J.O., 19 , Water resource management in the Northern Jordan Valley: KIDMA, v. p. 21-25.
- Ismael, Tareq, Y., "The United Arab Republic And The Sudan." The Middle East Journal.
- _____, Iran and Iraq: Roots of Conflict, 1982
- "Israel and Jordan Negotiate Indirectly About A Dam." New York Times, May 18, 1980, p. 4.
- Issar, A. and and Levanon, A., 1974, The Uses of Geo-physical Methods in Hydrogeological Investigations in Israel Hy.Sci. Bull, v.19, p.200-213.
- "Iraq," Arab Report And Records, October 16-31, 1978, p.764.
- "Iraq," Arab Report And Records, August 16-31, 1978, p. 590.
- "Iraq," Arab Report And Records, April 16-30, 1975, pp. 247-8.
- "Iraq," Arab Report And Records, May 1-15, 1975, p. 276.
- "Iraq's Arbil Irrigation Project," Economic Review Of The Arab World, August, 1982, p. 147.
- "Iraq's Development Projects," Economic Review of the Arab World, May, 1982, p. 86-87.
- "Iraq's Drainage Network In Tamim Governorate," Economic Review of the Arab World, July, 1982, p. 125.
- "Iraq's Irrigation Project," Economic Review of the Arab World, January, 1982, p. 7.
- "Iraq's Irrigation Projects," Economic Review of the Arab World, July, 1982, p. 124.
- "Iraq's Irrigation Projects," Economic Review of the Arab World, September, 1982, p. 165.
- "Iraq's Water Purification Plant," Economic Review Of The Arab World, Vol. XV, No. 1, p. 18.
- "Irrigation Ministry's Projects Completed," Economic Review Of The Arab World, March, 1982.
- "Irrigation Projects Allocated," Economic Review Of The Arab World, May, 1982, p.178.
- "Jordan: In Brief," Arab Report And Record, July 16-31, 1978, p.516.
- "Jordan: Economic," Arab Report And Record, August, 1, 1978.

- Kahhaleh, Subhi, "The Water Problem In Israel And Its Repercussions On The Arab-Israeli Conflict," The Middle East, March, 1982, pp.44-45.
- Kakhali, S. "The Cornerstone of Economy," Sotsialisticheskaya Industriia, Mar. 29, 1978. (Russian)
- Kaly, Elisha "Water and Peace" Of April 25 1974 (Hebrew)
- Kaly, Elisha, "Plan 'Sea Project' and the Peace Tendencies of Israel," Dayar, Jan. 18, 1983 (Hebrew)
- Kaly, E., 19 , Ideas and suggestions on water resources agreement within a regional Mid-East peace treaty: 6th IAEA Congress on "The Development of the Desert"
- Kamin, Y. "Reshaping the Desert," Solskaya Zhizn Apr. 18, 1974 (Russian)
- Khadduri, M. The Islamic Law of Nations, 1966.
- _____, Major Middle Eastern Problems in International Law, 1972, pp. 105-121.
- al-Khayr, Y. "Enjoying Equal Rights", Selskaya Zhizn, June 18, 1981, (Russian)
- Khalifa, Isam, "Why the Israeli Withdrawal will Stop at Sidon" Mustaqbal, no. 322, Apr. 23, 1983, pp. 29-34 (Arabic)
- Khoury, Rami, "Israel Drains West Bank Waters," Middle East, Sept. 1979, pp. 38-40.
- _____, "Garden Plots," The Middle East, September, 1982.
- _____, "Jordan's Ten Billion Dollar Hothouse," The Middle East, September, 1980, p.76+.
- _____, The Jordan Valley. London: Longman, 1981, 256 pp
- _____, "Returning to the Valley" Jordan Vol 8, no 1, 1983, pp.10-15.
- Kaul, R.N., 19, An integrated natural resources survey in northern Iraq: "Kirkuk River Project." Economic Review Of The Arab World, February, 1982, p. 65.
- King-Underwood, Annie, "Gulf Faces A Growing Food Crisis," 8 Days, December, 1981, p. 53.
- Labaki, Boutros, "L'economie Libanaise Face A La Guerre Du 5 Juin," le Commerce, July 26, 1982, pp. 10-13. (French)
- "Land Control In Lebanon," The Middle East, February, 1978.
- Landau, Eli, "Israel will Probably Prevent Repair of the Ghjor Canal Until the Jordanians Guarantee Peace on the Border," Maariv, Aug.

11. 1969 (Hebrew)

Lauterpacht, "River Boundaries: Legal Aspects of the Shatt al-Arab Frontier." International and Comparative Law Quarterly, Vol. 9, 1960, pp. 208-236.

Lycett, Andrew "Special Survey: Water Resources". Middle East Special Issue, no. 84, Oct. 1981, 79 pp

_____, "Agribusiness In The Middle East." The Middle EastPS, June, 1982, pp. 91-93.

Main, Charles T. Inc The United Development of the Water Resources of the Jordan Valley Region, Gordon Clapp, Gordon, (Chairman, Tennessee Valley Authority) United Nations, Boston MA 1953.

Maksimov, Y. "From Aswan to Alexandria," Sotsialisticheskaya Industriia, May 11, 1976 (Russian)

Maktari, A. Water Rights and Irrigation Practices in Lahj, 1971.

Masanat, Yusuf "The Economic and Political Implications of the Med-Dead Canal Project" Al-Tanmiyah Vol. 9, # 99, Sept. 1981, pp. 2-6, (Arabic)

Mazur, Michael P., Economic Growth and Development in Jordan, Croon Helm, London, 1979

McDougal and Schlei, "The Hydrogen Bomb Test in Perspective: Lawful Measures for Security," Yale Law Journal, Vol. 64, 1955, pp. 648-710.

Meissner, Frank, "Prospectives For Artificial Rain Enhancement In The Jordan Valley Development," Middle East Journal, Autumn, 1953, pp. 484-499.

Metral, Françoise and Jean, "Maitrise de l'eau et societe dans la Plaine du Ghab," Revue de Geographie de Lyon, no. 3, 1979, pp. 305-325, (French)

"Mosul Power Contracts Signed," Economic Review Of The Arab World, April, 1982, p.66.

Munford, Lewis (Edit.), 1971 The Ecological Basis of Planning The Hague, Nijhoff, 115 pp

Nadim, Asaad, et al. "Living Without Water," Cairo Papers in Social Science, Vol. 3, no. 3, Mar. 1980

Note, "Oil Resources in Occupied Arab Territories under the Law of Belligerent Occupation," International Journal of Economics, Vol. 9, 1972, pp. 533-593.

Nyrop, R., and others, Area Handbook for the Hashemite Kingdom of Jordan; Systems Research Corporation, the American University.

Washington D.C., 1979.

Ofner, Francis. "Israel Water-Use Expert, Growing Need Hones Adept Technology," Christian Science Monitor, July 19, 1978, p.10.

"Opposition to Israeli Plan for Mediterranean Dead Sea Canal" Arab Economist Vol. 13, no. 147 Dec. 1981, pp. 12-13

Orekhov, B. "Where the Euphrates is Tamed", Stroitel'skaia Gazeta May 24, 1972. (Russian)

Parkinson, H.L. and G.F. Worts, "A Brief Evaluation Of Ground-Water And Soils Potential For Irrigated Agriculture, Western Desert Of Egypt," US Geological Survey(Reston, Virginia, 1977).

Peretz, Don "Development of the Jordan Valley Waters" Middle East Journal Autumn 1955, pp. 397-412

Picard, L. Y., and Golani, U. (northern sheet) and Bentor, Y. K., Vroman, A., and Zak, I. (southern sheet), 1965, Geological Map [of Israel].

El-Rassi, Georges, "Euphrate - Une difficile partage", In: "Cinq Barrages Cinq Problemes" Dossier L'Economiste du tiers monde no. 24 Nov.Dec. 1977, pp. 30-31 (French)

Rich, V. "Drought could turn Dead Sea into a Desert". Nature Vol. 281, Oct. 18, 1979, pp. 516-517.

Ross, Ron, "Israel...Where Irrigation Is An Art," IA, September, 1978, pp.6-9.

Rzoska, Julian, Euphrates and Tigris: Mesopotamian Ecology and Destiny The Hague, London, 1980, Dr W. Junk (Monographiae Biologicae; v 38), 122 pp

_____, On the Nature of Rivers: with case studies of Nile, Zaire and Amazon The Hague, Boston, 1978: Dr W. Junk pp

Saha, Suranjit K. and Christopher J. Barrow, 198 River Basin Planning - Theory and Practice John Wiley & Sons, New York (etc), pp

Saliba, Samir N., The Jordan River Dispute Martinus Nijhoff, The Hague, The Netherlands, 1965.

Schacht, J. An Introduction to Islamic Law, 1964.

Schmida, Leslie, Keys to Control - Israel's Pursuit of Arab Water Resources American Educational Trust, Washington, DC, 1982, 35 pp

Selbat, N. Water Policies Alternatives for Israel, 1981

Shmarov, V. "The Energetic Heart of Egypt", Sotsialisticheskaya Industriia, Apr. 12, 1974. (Russian)

Simpson, Barbara, and Carmi, I., 1983, "The Hydrology of the Jordan

tributaries (Israel): Hydrographic and Isotopic Investigation": Journal of Hydrology, v. 52, p. 225-242.

Sirait, Anne and Allen Pollack (ed.), Hashemite Kingdom Of Jordan And The West Bank, American Academic Association For Peace In The Middle East (New York, 1977), pp.65-113.

Smith, C. G. "The Disputed Waters of the Jordan". Institute of British Geographers, Transactions, no. 40, Dec. 1966, pp 111-128

Smith, Chris. "From Farmers Into Labourers." Middle East International, No. 203, June, 24, 1983 pp.14-15.

Smith, "The Waters of the Jordan." International Affairs, Vol. 25, pp 415-425.

Starr, Joyce R. (Ed.) A Shared Destiny - Near East Regional Development and Cooperation. Praeger Publishers, New York, 1983.

Stauffer, Thomas "Israel's water needs may erode path to peace in region" Christian Science Monitor Jan. 20, 1982, pp.78-79

_____, "The Price of Peace, The Spoils of War" American-Arab Affairs no. 1 1982, pp. 43-54.

Stevens, Georgiana, 1965 Jordan River Partition Stanford Univ. Press, Hoover Institution on War, Revolution and Peace, Stanford, CA., 91 pp

_____, "The Jordan River Valley" International Conciliation no. 506, Jan. 1955, pp. 227-283.

Stone, J. Legal Controls of International Conflict, 1954.

Stork, Joe "Water and Israel's Occupation Strategy" Merip Reports No.116, vol. 13 #6, 1983, pp. 19-24.

Sudakov, V. "A Fruitful Cooperation." Selskaya Zhizn, Jan. 7, 1981, (in Russian)

"Syria." Arab Report And Records, April 1-15, 1975, p. 230.

"Syria." Arab Report And Records, May 1-15, 1975, p. 289.

"Syria's Kabeer Al-Shimali Dam." Economic Review Of The Arab World, April, 1982, p. 147.

"Syria's New Water Projects For Dara'a." Economic Review Of The Arab World, April, 1982, p.152.

Tabor, Harry, Z., "Using Solar Energy To Desalinate Water." Alternative Futures, Vol. 28, No. 4, October/December, 1978.

Tal, Yerah, "The Water Commission will not Supply Irrigation Water to Settlements on the West Bank." Haaretz, Nov. 10, 1983 (Hebrew)

Tarbush, Susannah. "Lebanon-A Sinister Calm." Arab Report, February, 1979.

Teclaff, L. The River Basin in History and in Law, 1967.

Toebes, C. and V. Ouryvaey (Editors), Representative and Experimental Basins - An International Guide for Research and Practice UNESCO, UN, New York, pp

Temko, Ned. "Water-Toughest Issue On The West Bank," Christian Science Monitor, September 18, 1979.

El-Tobgy, H.A. Contemporary Egyptian Agriculture Fortd Foundation, Cairo, 1976, 2nd ed. pp 228.

Tsaplin, Y. "Between the Tigris and the Euphrates," Sotsialisticheskaya Industriia, Jan. 30, 1977 (Russian)

Tsibizov, A. "An Ever-growing Cooperation" Solskaya Zhizn, Feb. 4, 1978 (Russian)

Tunkin, G. The Theory of International Law, (Butler trans., 1974)

United Nations. Groundwater in the Eastern Mediterranean and Western Asia, Natural Resources/Water Series #9, UN, New York, 1982.

_____. Management of International Water Resources: Institutional and Legal Aspects, Natural Resources/Water Series #1, UN, New York, 1975

United Nations, Unesco, 1970 Hydrology of Deltas y 2, IASH/AIHS - Unesco, Gentbrugge-Paris, 491 pp

United Nations, World Health Organization-WHO "Water source and sustenance of life". Impact of Science on Society 26:237-238 1974

U. S. Department of the Interior, U.S. Geological Society "Recent and Projected Changes in Dead Sea Level and Effects on Mineral Production from the Sea". Open-File Report 78-176, Reston, VA, 1978, 43 pp

U. S. Government, Council of Environmental Quality, and The Department of Interior, 1980 Global 2000 - Report to the President Penguin Books, New York, pp

Vahidi, Iraj, "Groundwater investigations in Iran": Paper No.1 in The Development of Groundwater Resources With Special Reference to Deltaic Areas; Water Resources Series No. 24, UNESCO.

van Aart, R., Drainage and land reclamation in the Lower Mesopotamian Plain p. 11-17.

Van Liere, W.J., 1961, Observations on the Quaternary of Syria; Proc. of the State Service for Archeological Investigations in the Netherlands, 10-11, p. 7-67.

- Vannus, M. "Inestimable Assistance," Sotsialisticheskaya Industriya, Apr. 12, 1974, (Russian)
- de Visscher, C. Theory and Reality in Public International Law (Corbett trans., rev. ed. 1968).
- Voute, Caesar, "Climate or Tectonics? (remarks on the evolution of the Orontes Valley)" Geologie en Mijnbouw, Aug. 1955.
- Wallace, Jonathan, "Water is Jordan's Top Priority," MEED, March, 23, 1979, p.35.
- West Bank Resources And Its Significance To Israel, Royal Scientific Society(Economics Department, April,1979), pp. 7-10.
- "Water Politics" The Middle East Special Report, Feb. 1981, pp.47-54.
- "Water Power - Who Turns the Tap?" Arab Report, Mar. 14, 1979
- "Water Projects In Bagdad," Economic Review Of The Arab World, Vol. XV, No. 4, April, 1982, p. 176-177.
- "Water, Source And Sustenance Of Life," Impact Of Science On Society, Vol. XXIV, No. 3, 1974, pp.237-238.
- Weulersse, Jacques, Le Pays des Alaouites, Arrault, Tours, 1940.
- White, Gilbert Fowler (Edit.), 1977 Environmental Effects of Complex River Development Boulder, Westview Press, xi 172 pp
- Wiseman, Robin "Water Decades Goals Recede as Population Grows", Middle East Economic Digest, vol. 26, no. 13:16-18 M 26 1982
- Wilkinson, Joseph, E., "Water-A Matter Of Dollars And Sense," Engineering News Record, April 30, 1974, 159-167.
- Wolfart, Reinhard, 1967, Geologie von Syrien und dem Libanon; Gebruder Borntraeger, Berlin-Nikolassee, 326 p.
- "WORRI: The World Register Of Rivers Discharging Into The Oceans Computerizing Hydrological Data," Nature And Resources, Vol. XV, No. 1, January-March, 1979, p. 30+.
- Wothington, E. B., 1976 "Arid Land Irrigation in Developing Countries: Environmental Problems and Effects" International Symposium, Alexandria, Egypt, Pergamon Press, New York, pp
- Zoller, Uri, A Chemical Profile Of Recycled Irrigation Water In North-East Israel, Elsevier Scientific Publishing Company(Amsterdam, 1979).

EN
DAT
FILM